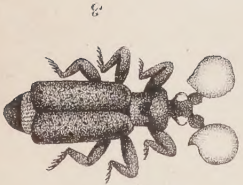
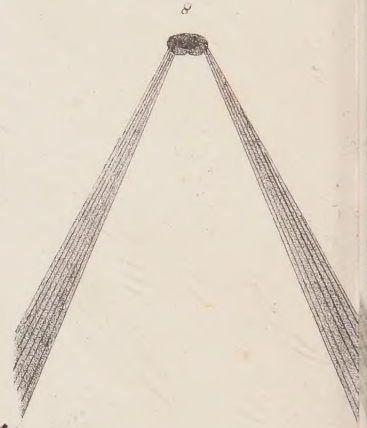
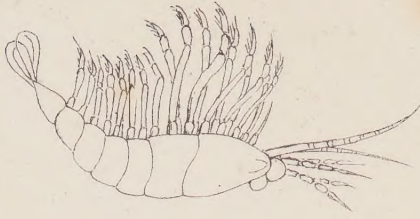
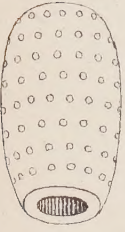


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To
Sir William Jardine Bart
Jardine Hall
with the Authors
Respect & Compliments



RESEARCHES
IN
NATURAL HISTORY.

Second Edition.

— Equidem credo, quia sit divinitus illis
Ingenium. Virg.

BY JOHN MURRAY,

F.S.A. F.L.S. F.H.S. F.G.S. &c. &c.

LONDON:
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TO
PATRICK NEILL, ESQ.

F.R.S.E. F.S.S.A. F.L.S. F.H.S. &c. &c.

EDINBURGH,

INSCRIBED

TO RECORD THE AUTHOR'S

ESTEEM.

JUNE, MDCCCXXX.

PREFACE

TO THE SECOND EDITION.

THIS volume is a new edition, or rather a new work, and fraught, it is hoped, with renewed interest, from the increased number of facts and recorded phenomena. Much has been expunged that was, on reflection, presumed to belong more naturally to another branch of science, or at least made the question too complex and abstruse; such as the preliminary remarks on Light, which might generally be supposed extraneous and irrelevant. Subsequent researches and more extended experiments have also enabled me to modify and enlarge my remarks, or fortify and confirm my previous conclusions.

The least agreeable part of my task is to combat the opinions of those from whom I differ. I allude here to the paper of Mr. Blackwall in the Linnean Transactions on the ascent of the gossamer spider, and the subsequent controversy to which it gave rise, and to Mr. Rennie's Remarks in "Insect Architecture." My views on the principles by which the gossamer spider effects its ascent, possessed as they were of *novelty*, and published long before Mr. Blackwall had ever turned his attention to the subject, could not be expected to run the gauntlet of public opinion without scrutiny, and accordingly they have been canvassed and questioned. I trust it will be found that the facts

are honestly stated, and the opposite opinion weighed without prejudice in the balance of induction. As regards myself, the more I extend my observations the more fixed and settled is my conviction. Should the agitation of this very curious subject excite others to the enquiry (and it seems to have already roused M. Virey in France), it will accomplish something; and should future investigation prove me in error, I shall cheerfully acknowledge my mistake;—my conclusions *may* ultimately be found incorrect, but the registered facts will still remain the same. Unfettered by any hypothesis or preconceived opinion, I shall continue my researches and pursue my experiments. In order to afford a better illustration of some of the luminous animals, terrene as well as marine, described, and a phenomenon connected with the flight of the spider, a plate has now been added to the volume, from the lithographic press of Mr. Hullmandel.

What has been withdrawn is substituted by new and interesting matter obtained from various sources, intermixed with details of original research and remark: in the disposal of these accumulated materials I have endeavoured to be select, and as little diffuse as possible. In reference to the phosphorescence of the ocean, I confess myself under considerable obligations to Mr. Thompson's curious and original "Zoological Researches,"—a work that bears in addition to its other interesting qualifications the evidence of much industry. To its ingenious author we owe the discovery of that "rara avis" the *pentacrinus europæus*, found in a living form in the Cove of Cork.

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DESCRIPTION OF THE PLATE.

FIG. 1. *Fulgora lanternaria*, one third its natural size.

FIG. 2. *Fulgora candelaria*, less than the natural size.

FIG. 3. *Pausus sphæroceros*, magnified.

FIG. 4. *Lampyris noctiluca*, male and female.

FIG. 5. *Cancer fulgens* of Sir Joseph Banks (*Noctiluca Banksii* of Thompson), magnified.

FIG. 6. *Sappharina indicator* of Mr. Thompson, magnified.

FIG. 7. *Pyrosoma pygmea* of Mr. Thompson, magnified.

FIG. 8. Phenomenon in the ascent of the "Gossamer Spider."

RESEARCHES

IN

NATURAL HISTORY.

CHAP. I.

INTRODUCTION. — PRELIMINARY REMARKS ON THE
TONE AND TEMPER OF MODERN SCIENCE. — INTRO-
DUCTORY WORKS ON SCIENCE. — ASPECT OF NOMEN-
CLATURE, AND ITS MUTABILITY.

NATURAL History is now much cultivated among us, and its study seems eminently calculated to soothe the mind and soften the affections of the heart, — virtues that will not flourish amid the abstract mathematical sciences, — though we would not be understood to decry their worth and underrate their usefulness. Both sexes, and every age, may enjoy this pursuit, and make their election of that which is most congenial to each. Healthful pleasures are attendants in her train: we are not trammelled by the mechanism of art, wearied by the sedentary labours of the closet, or suffocated by the fumes of the laboratory: “we walk,” as Sir J. E. Smith has expressed it, “with God in the garden of creation, and hold converse with his providence;” and this feeling will be equally enjoyed, whether we “consider the lilies of the field how they grow,” or

contemplate the more complex forms of the higher links of organised existence. There is wonder everywhere excited in this world of wonders.

The tone in which scientific truths are now promulgated is also changed for the better. In its investigations, the mind seems to have become much more independent, less the slave of authority, and less obedient to the trammels of system and the idol-worship of a name. The days of its alchymy have passed away, and the hermetic seal is broken;—we hope these days of darkness will never return. The modulation of scientific literature has now a more musical charm, and reaches the heart, as well as informs the head. The style and feeling displayed in such works as these,—“*Salmonia*,” “*Journal of a Naturalist*,” and the “*British Naturalist*,” remind us forcibly of the good old times of Eveyln and Walton, Derham and Ray, and, last not least, the amiable philosopher of Selborne. We think that one obvious cause of this welcome acceptance will be found in the rightful appeal that is made to the BEING who made them all, and which vibrates through their pages like a silver chord—a key-note unhappily overlooked or forgotten by our modern philosophers, with whom scepticism and infidelity seemed almost essential to complete the character, and an occasional sneer at Revelation the truest passport to their “*Atalantis*.” HE “who rideth on the whirlwind, and directs the storm,” and whose “still small voice” is ever “heard among the trees of the garden,” and the fiat of creation, was to them “an idle tale that they believed not,” though the golden link that suspends its harmonies. This unbelief proved a treacherous abandonment of the principles under which they professed to be enlisted, which the event has shown to be repulsive to the best features of the true philosophy of the human mind.

It has been tried in the balance, and found essentially wanting. We are no friends either to puerile sentimentalism or morbid morality; but, "believing it in our hearts, shall we be ashamed to confess it? Shall we deny the wisdom of our Maker, because he is all wise; or his power, because he is all powerful? Shall we respect the works and condemn the Maker?" *

Another cause impeded the progress of knowledge: her books were sealed with the impress of technical terms, and contained words formed of inflexible materials; so that an interdict was imposed on nine-tenths of those who would have willingly and gladly consulted them, — who would have read them, but could not, — and thus the readings of creation in the writings of genius were as unintelligible to the general reader, as the hieroglyphic symbols of aboriginal Egypt. Science has now assumed a more popular form, and numerous are the attempts to

" Robe fair Science in a pleasing garb,
Then lead the young to view her."

All this is laudable, and must tend to promote human happiness. The fountain of this department of knowledge never sends forth the "waters of Marah:" it is a copious source, and, like that of its almighty Author, ever flowing, and yet ever full. The tree of knowledge is not, indeed, the tree of life; but they flourish in the same Eden; both were planted by the same hand, and are watered by the river of "Araby the blest." Sir H. Davy says, "The tree of knowledge is grafted on the tree of life:" we think them different. In Botany, and Entomology, and the higher departments of Zoology, the entire descriptive formularies are in

* British Naturalist.

the language of the Latins; not in its purest form, or the classic elegance of ancient Rome, (for that were some relief,) but a mere scholastic display of barbarous Latinity, — something like the prescriptions of the physician, — containing a series of mystic and free-masonry signs to the initiated apothecary; and, in consulting them, we shall but too readily perceive that it indeed falls to the lot of few to write with the classic diction of a Gregory. In saying thus much, we would not be understood to declaim against system or nomenclature, as we are decided advocates for both; indeed, it is not easy to perceive how science could make any progress without them: but the language of nomenclature should be wisely fixed, and, when once universally admitted, should be suffered to remain undisturbed; science is now likely to suffer wrong, from an extraordinary propensity in this direction: an arbitrary change of terms is now the unhappy temper of the fashion of the day, restless for something new, even in the sound of a novel name:

“ A rose

By any other name would smell as sweet;”

yet we have no right to dethrone that name, consecrated by the rights of antiquity, and acknowledged by the modern science of a world.

The authority of Linnæus and his terms is disputed even by those who subscribe themselves his disciples, and call themselves by his name. This conduct is very ungrateful, or, to say the least of it, inconsistent. In some parts of the *Systema Naturæ* of that extraordinary man, recent discovery found something wanting, and in others imperfection: but these, surely, are not valid reasons to doom the whole fabric to destruction. Now, the various sections of natural history have each their peculiar banners, inscribed,

Jussieu, Lamarck, Latreille, and others. Having found the difficulties of a change of masters, we feel somewhat sensitive on this question, and are greatly deceived if others have not had equal difficulties. None can pretend to have done what Linnæus did:

Secuit congeriem, sectamque redegit in membra;

and none, therefore, had so legitimate a right to settle its nomenclature as he; which, with all its faults and imperfections, is far better than any thing we have obtained in return; in some instances we have received base coin in lieu of our genuine metal; and far more numerous blots may be found in the escutcheon of these new leaders and arbiters of the destinies of natural history, than are to be discovered in the *Systema Naturæ*. The *Helix ianthina* and *Mya margaritifera*, are just as good, in our humble apprehension, as the *Ianthina* and *Unio* genera of the Testacea of Lamarck. This sectarianism of science can serve no possible good, but may be productive of infinite mischief. In saying thus much, while it is evident that generic and specific names must have a fixed nomenclature, not subject to caprice or whim, and, when fixed, remain the monument of ages; we regret that these have been too often the ideal creation of the exhibitor, or even invented to gratify spleen (*Smithia sensitiva*, and others): a nomenclature is, therefore, necessary and essential; otherwise the greater number of recorded and observed phenomena would be lost to the republic of science. The Linnæan names were received all over the civilised world, but jarring attributes now mingle their discordant notes, and mar the charm of modern science.

A great part of our modern elementary works on science, as Botany, Entomology, and Conchology, pre-

sent nothing to the student but a mere *catalogue raisonné*, — collections of names, and occasional descriptions of forms; little else besides, seldom even an allusion to habitats and habits, and the thousand wonders their physiology affords. The labours of Brisseau, and Mirbel, Reaumur, and Bonnet, and many others, British as well as continental, seem to be thus too lightly esteemed, though a brief space occupied in this way might excite attention to what might be otherwise overlooked. Phenomena stated as observed by some might be thus confirmed, and new facts established. We greatly mistake if the student and tyro is not as anxious to find his path strewn with flowers as any other; indeed, he seems most to require it; for, in the mere discrimination of one plant, or insect, or shell, from its congeners, there is much labour and tedium: it is a duty surely to cheer and enliven that lassitude, and afford some *point d'appui* for the mind to lean upon in its peregrination. Why not therefore, associate both — Nomenclature and Physiology? This would very much relieve the mind when it is weary. Mere discrimination alone will be of very little service, either to social or civil life; and, to be practically beneficial to these, there must be something more. A mere collector of plants, or insects, or shells, or one who can call them by their names, and assign their proper place in the *Systema Naturæ*, is worthy less praise than he who can depict their curious physiology, or trace their relative uses. Fresh excitements would thus be afforded at every step, and new acquisitions to knowledge obtained: for the student, as he climbs the steep acclivity, or rambles through the woods or the dell, or saunters by the brook, if provided with brief abstracts of what has already been discovered in the natural history of this

plant, or that insect, would be careful to register any other phenomenon that might accidentally occur, which he finds unrecorded. He might otherwise pass it unheeded, under an impression that it must doubtless have been observed before, and not be a reservation for him. Such manuals might be easily formed, and, if we mistake not, are desiderata. We merely suggest, — do not presume to dictate, — though anxious to reap more benefit from the labours of the student than has been hitherto obtained.

The reason of the popularity of the “Introduction to Entomology,” by Messrs. Kirby and Spence, becomes obvious enough; but these *tomes* are too ponderous and expensive for the general student, though they are volumes replete with curious facts, and record valuable phenomena, while the asperities of nomenclature and dogmatism of system are softened down and rendered palatable. Increased evidence is presented in the “Natural History of Insects” of the “Family Library,” and others — all which have, as it were, taken the public by surprise, and the necromance of novelty, — just as if the key of knowledge had been taken away, and for the first time restored.

Tempora mutantur, et nos mutamur in illis !

CHAPTER II.

THE CHAMELEON. — INTRODUCTORY REMARKS. — VARIOUS OPINIONS. — PHENOMENA OF CHANGE, BY VARIOUS OBSERVERS. — DIFFERENT DEDUCTIONS. — THE TEMPERATURE OF THE CHANGING SHADES AND SPOTS ADDUCED AS A PROOF OF THEIR DEPENDENCE ON CIRCULATION. — ANALOGICAL PHENOMENA.

THE chameleon is a curious and interesting animal, and exhibits features of a very unusual kind. The earlier naturalists could not well overlook a character so extraordinary; and it found a place in their pages. Fable has drawn on its changes, and poetry has consecrated these wonders by the witchery of song; neither is there a more singular train of phenomena, nor a problem of more difficult solution. Its physiology is of no ordinary kind; and the singular mutability to which the creature is subject involves a question of an uncommon complexion.

The *Chamæleo vulgaris*, or common chameleon, is a native of Europe, Asia, and Africa. Its wonderful changes have excited attention in every age, and become proverbial. This remarkable phenomenon is not exclusively peculiar to the chameleon; for it would appear that both the *agama* and *polychlorus* occasionally display various colours, even the *deep black* which the chameleon sometimes assumes occurs also in them. To account for these changeable hues, seems to have exhausted the imagination and ingenuity of the observers. Thus, Linnæus and Hassel-

quist thought they arose from *jaundice* ; Kircher, from the imagination of the animal ; Solinus, from reflection ; Wormius, from the affections of the mind, an opinion nearly that of Lacépède ; Shaw and the French academicians, from exposure to the sun. Pliny and Russel concur that the animal takes the colour of the body with which it may happen to be in contact. D'Obsonville, Dumeril, Cuvier, Barrow, and the authors in Rees's Cyclopædia and the Edinburgh Encyclopædia, seem to think that the change is somehow connected with the functions of respiration. Mr. Spittal believes that the colour depends upon the quantity or tint of the blood sent to the skin at different times ; and thinks that, from the translucency of the skin, it is probable that the particular states of its surface must also have a share in the production of colour, by affecting the rays of light differently at different times. It is to be regretted that the effects of electrical stimuli, and the insulated colours of the prism have not been tried.

The following paragraph, on the habits of the chameleon, is extracted from the "Calcutta Journal :"—
 "I have kept," says the writer, "chameleons in a cage several months, narrowly watching them, and have placed them on different substances for the sake of experiment. I never saw an alteration in their colour, but merely a variation in their shade, from a light yellowish green to a very dark olive green ; the mottles were always visible, though changed similarly with the shades. The chameleon's tongue, which is nearly three parts the length of his body, is blunt at the end, and not unlike a common probe. From the end of it exudes a small quantity of matter, thick, clear, and glutinous. This he uses in obtaining his prey, which consists entirely of insects. He will re-

main sometimes for an hour with his tongue on the ground, and when a sufficient quantity of insects has settled upon it, they are all drawn in and devoured. I have seen this animal dart at a fly settled upon a small piece of paper: the fly escaped, but the paper was drawn to the mouth by the cohesive liquid just referred to, and which I have several times particularly examined. The chameleon possesses the quality, generally attributed to him — of a power of long fasting.” We are indebted to P. Neill, Esquire, for the following memoranda on the chameleon, made by his gardener, A. Scott:—“When the chameleon was in good health, and moving from plant to plant, or catching its prey, it was nearly of a uniform colour, with slight variations of shades of green: when within a few inches of the glass, in warm sunshine, it generally assumed its most remarkable colour, though sometimes mottled with dark green or brown spots, when not particularly situated: when near the glass at the top of the house, the colour appeared to be the same, whether viewed from beneath within, or from above through the glass, without, and seen in a direction parallel to the solar rays; whatever was the angle, in fact, or position, there was no difference: when one window-sash was lowered over the other, the animal sometimes crept between them; on different occasions, the glass had to be broken, in order to remove it safely; and on such occasions it was easy to survey the animal in the positions mentioned. Though attentively observed, whether the adjoining and surrounding objects contributed to the changes, nothing could be distinctly ascertained beyond what might reasonably be supposed accidental; though change of place, while the chameleon was assuming any particular shade, soon produced a change of

colour. In general, when any particular change was effected, two longitudinal rows of light spots first made their appearance; and although these particular parts of the body assumed a variety of shades, perfectly distinct from each other, yet it seldom happened that we could not distinguish the two rows as presenting a shade different from the rest.

“The chameleon sometimes assumed a colour resembling lead or zinc, but rather of a darker blue; when of this tint, there were no spots visible on any part of the body, and this was the only shade observed to be void of spots: when the general colour was like coal or coal-dust, the animal had brass-coloured spots of various sizes, sometimes arranged in rows, and sometimes scattered; the tail was then alternately marked by rings of the two colours. Though sometimes considerably irritated when food was given, no change of colour ensued. The chameleon seemed to be most offended at one of the tortoises that came in contact with it on the footpath, and, when first observed, the tortoise was creeping unceremoniously over it; yet though, in this case, the creature was comparatively in the dark, the colours were in most conspicuous array. In candle-light it was of a dirty white, resembling mortar. The chameleon was once placed on a scarlet silk handkerchief, in sunshine, out of doors, and remained on it for 15 or 20 minutes without any change having taken place. It was afterwards carried into the shade, and put on the ground, from whence it moved away very slowly, and soon became of a very light green, with numerous dark green spots, which disappeared when it came into sunshine.”

Mr. Neill observes, that it was fed chiefly with *sclaters* (*Oniscus ascellus*) or centipedes (*Scolopendra forficata*), and the small translucent *lumbrici*, or earth-worms

found among tan. In winter, its food was put into the animal's mouth; and in summer, *spiders, flies, &c.* were captured by itself: the tongue was sometimes darted forward so strongly at its victim, that it has been heard to strike the glass sharply. "On one occasion," says Mr. Neill, "the colour of the neighbouring leaf seemed to have influenced the colour of the animal. In the morning, the chameleon was of a dirty cream colour, the most frequent colour during night, and when asleep:" in this instance, "it was observed to be of a bright glaucous green on one side of its body, and of a dull leek green on the other. The bluish side was directly exposed to the light of the sun passing through a newly unfolded banana leaf of a delicate texture," and when removed on the finger to the shade, these shades of green continued evident for some time. The animal came from Malaga, and was one of several received by Professor Jameson. It lived nearly a year in Mr. Neill's hothouse at Canonmills.

In Professor Jameson's Philosophical Journal, for April, 1829, Mr. Spittal has supplied us with several interesting facts concerning the natural history of the chameleon from personal observation on some living specimens received by him from the south of Spain. They measured five inches in length, exclusive of the tail; the colours observed were compared with corresponding tints in Mr. Syme's "Werner's Nomenclature of Colours;" and it is much to be desired that some fixed standard of this kind were had recourse to in determining the various shades of colour in natural history. "The usual colour observed during the day was a mixture of various shades of green in irregular spots towards the head. These, however, sometimes assumed the form of stripes; sometimes these colours were slightly mixed with yellowish patches, and at

other times with dark purple spots." It was occasionally difficult, he observes, to discover the animals among the leaves; in all probability a beneficent provision, enabling the animal more successfully to obtain its insect food, being thus more easily surprised: at night, the colour appeared to be yellow: on a candle being brought within a few inches of the side of one of these chameleons, the light-brown spots began to appear at irregular distances on the side next the light; these spots deepened in colour till they became of a dark brown: when the light was removed to a distance, the spots as gradually disappeared, and the animal assumed its usual yellowish hue: the same effect was produced by an *irrigation*, in imitation of a gentle shower: the animal remained asleep in both cases. On one occasion, the chameleon escaped from the greenhouse, and was found among some long grass, and invested with rather an extraordinary livery, being speckled black and white; the colours were in large irregular patches: when in this state, its dimensions were contracted, as was the case when of a dark colour; a fact observed by Mr. Forbes, especially when the animal became black. On one of these being irritated, the colour changed from the usual greenish mixture to that of a yellowish gray, spotted over with numerous red points, about the size of a pin's head; the animal became inflated, and it attempted to bite the finger. When the animals became weak, and some short time before they died, their colours were very different from what was observed during health. They became yellow and purple, displayed in large irregular patches, and seemed gradually to brighten as the animals became weaker, and on death they were brightest. This finds a striking analogy in the dolphin; as, on the approach of death, the colours become more bright. When the

animals were in health, a change generally took place in the shade every ten minutes; but at night little alteration was perceptible, and the hue was more permanent. Mr. Spittal observes, that he feels assured, he “observed the shadow of the wires of the cage, during the bright sunshine, through the body of one of them while in a compressed state, and we are told that the chameleon, in a wild state, often appears as if it were translucent or semi-transparent.

Mr. Madden informs us, that the chameleon is so exceedingly irascible, that he easily trained two large ones to fight, which they would do on causing them to strike their tails the one against the other. During their excitement, the change of colour becomes very conspicuous, though, by Mr. A. Scott’s communication to us, the animal may be irritated without this mutation of colour supervening. Mr. Madden supposes that the bile of the chameleon, being visible in the blood under the pellucid skin, affords, as it passes through the circulation, three distinct shades of green. This seems, however, to be the introduction of an occult cause, nor is it necessary to suppose any other than an accelerated circulation to account for the phenomenon. A languid or hurried circulation will necessarily be connected with a greater or lesser degree of oxygenation, a fact proved by the variable temperature exhibited in the colours of the skin: venous blood is dark, and arterial a bright red colour; and these colours depend on chemical change; they are of different temperatures, and intermediate shades may be formed by their mixture.

Monconis relates, that the chameleon appears green in the sunbeam, and *black* when seen by candle-light. Perhaps Merrick, on this assumption, has ventured to record the circumstance. That it can change to a deep

black, has been clearly proved. He also mentions that, being shut up in a box, and put on white paper, it becomes yellow and green, and affirms that it can assume only these four colours. Mademoiselle Scuderi, in her observations and experiments, states, that, being exposed to the sun, the chameleon often changes its colour, without taking that of the superficies on which it moves.

Professor Blumenbach has not, that we are aware, given us any where his opinion on the change of colour in the chameleon; but one of his friends, to whom that opinion was verbally communicated, informed us, that he considered the varied colours to depend on the angles of position in relation to the eye. That the change of colour, however, is *real*, and not a *deceptio visûs*, no one can for a moment doubt who has accurately observed the phenomenon: the change of colour often takes place *instantly*, without change of position either in the animal or the eye of the observer, and the difference of temperature proves this reality. It is also well ascertained, that the animal does not assume the colour of the surface it traverses. It seems, therefore, altogether demonstrable, that the change of colour in the chameleon is ascribable to the circulation, as affected by its instinct passion, excited or roused to action; and that light, acting on this circulation through the cuticular membrane, may, in virtue of its electric or calorific power, deepen the shade of the bands and spots: the entire shade will often be observed to fade away, or increase in depth and intensity; oftentimes the changes are only partial, and exhibited on some particular parts of the body; when handled, it appears to be dark green. If wrapped in linen, it seems whitish when withdrawn, though this does not always happen. When the one we saw at Exeter'Change, how-

ever, was withdrawn from its envelope of cotton-wool, it was very pale; but the animal seemed weak.

Some winters ago, we saw a living chameleon, for the first time, in Exeter 'Change menagerie. It was sickly, and no experiments could be made upon it. In the month of July, 1824, we had, however, this opportunity, on a fine healthy chameleon, brought to Hull by the captain of a ship, from Sierra Leone, on the coast of Africa. It is not our intention to enter upon a particular description of its exterior appearance, it being sufficiently well known from the numerous specimens in the various cabinets of Europe, as well as those in private collections. The eyes are singularly constructed, and merit a passing notice; each one being a rich and brilliant gem, set in a ring of gold, and enchased in a spherical socket; being adorned on the superficies with radii uniting in this beautiful point of vision. Each ball performs its revolution entirely independent of its counterpart, and even when one eye shuts, the other remains the watchful sentinel: the globe, under such conditions, seems absorbed, and its convexity discovers a depression. The eye appears remarkably intelligent and acute, and it seemed to contemplate the ball of the thermometer, during the progress of the experiments, with a curious interest. We have merely singled out the organ of vision, as not the least interesting feature of this elaborate structure, in which such exquisite design is every where manifest. The pace of the chameleon is slow and measured; the vertebral column is dentated, and the skin is rugose or wrinkled: its food is derived from the insect world, and coleopterous and other insects are discovered in its egesta. When a fly settles near, it moves with extreme caution to a convenient distance and position, and, darting its tongue, imbued with viscid

saliva, to the spot, it is entangled and ingulfed in a moment; sometimes the tongue will be extended to the length of five inches out of its mouth; — so that its living on air is a mere fable. One we saw, had lived many weeks without food; so that its occasional abstinence may be very great. Mr. J. M. Davies, of Gosport, possessed a live chameleon, the favourite pet of his family, apparently delighting in crawling over them, and receiving food from their hand. The last time we saw the living chameleon was in Mr. Neill's conservatory, reposing at perfect ease on the stem of a *Passiflora quadrangularis* with its prehensile tail coiled round the plant.

Our experiments were made on the TEMPERATURE of the animal, as connected with the changes of colour depicted in such varying shades on the surface of the skin; and the magic of the necromancer's rod takes not the sense of vision more completely captive than do these ephemeral and sportive hues. In numerous experiments, we have clearly and satisfactorily ascertained that each tint of the chromatic series of the prism invariably discovers a temperature peculiar to such specific colour, and in a constant ratio of progression; and, in the subsequent experiments, we employed a very delicate and sensible thermometer, instantaneously affected by contact.

20th July, 1824, at 55 minutes past 4, to 10 minutes past 5, P. M.; temperature of air, $72^{\circ}.5$ Fahrenheit; ball in contact with either side, 73° to $73^{\circ}.5$ F.; ditto ditto, $73^{\circ}.5$ to 74° F. As the tint varied from a yellowish green to a deep pea-green, the side farthest removed from the source of light, in all our observations, constantly discovered the *lightest* colour; and when that side was purposely turned toward the window, it assumed, in a short time, the darker shade,

while the other softened down proportionally into the lighter tint; and when the light was equalised, the two sides were of similar complexion. Air, 72° ; temperature of skin, 73° on lighter side, and $73^{\circ}.25$ on the dark green side; yellow field of colour, $73^{\circ}.5$ F. In another experiment, the yellow was $74^{\circ}.5$ F. While moving on the floor it became very opaque, the darker spotted bands exhibited a temperature of $75^{\circ}.25$; and it is worthy of remark, that where the ball of the thermometer rested, though the pressure was gentle in the extreme, the spot became *white*. 21st July, at 30 minutes past 10, A. M.; air, $69^{\circ}.5$ F.; neck of the chameleon, $70^{\circ}.5$; dark-coloured band, $71^{\circ}.5$; lighter parts, 71° . In sunshine, the bands, zebra-like, became remarkably distinct, and the darker shades indicated 74° , while the intermediate green grounds oscillated between $72^{\circ}.75$ and $73^{\circ}.5$ F. We do not believe that the coloured ground, traversed in any way, affects the evolved tint, excepting so far as the *light* reflected and modified from various coloured surfaces, may operate differently on the circulation of the blood; since we presume that the change of colour is in accord with the circulation of the blood as affected by the action of light on the vital fluid through its membranous envelope. As the circulation is languid, or more active, in its flux through the system, a corresponding colour will be developed, to announce this new phenomenon of chemical change, superinduced by the stimulus of light on the blood, and this tint will be a faithful index of its amount. The colour, too, we have concluded, is the medium by which the temperature of the system is equalised. Hence, too, the negro tint may subserve an equally important end in the system.

Dr. Wilson Philip has proved that nervous influ-

ence is analogous to electric energy, or is at least obedient to the latter, and made to flow at its command; Mr. Thackrah shows that the *vitality* of the blood is maintained by nervous influence; and Dr. Carus of Dresden discovered the circulation of blood in insects, and that the decrease and increase, with its intermission in the light, of the *Lampyrus italica*, corresponded with the pulsation of the blood. Just so is it with the chameleon: the temperature of the blood is proved variable, and the colour cast up on the skin is its index. It may not be irrelevant to the question to state, that the blood is presumed to be warm in proportion as it is nearest the heart, and that arterial blood exceeds, by about one degree, that of the veins. By Mr. Hunter's experiments, it appears a moderate degree of inflammatory action is capable of elevating the temperature of the blood 4° F.; and it is evident that irritation or excitement produces an action somewhat analogous. Violent passions of the mind cast up their crimson or roseate hue on the skin, and we feel the fevered warmth playing on the face. The range of temperature we observed on the skin of the chameleon rose from 70°.5 to 74°, nearly the difference observed by Mr. Hunter between the ordinary state of the blood and that of common inflammatory action. Specific colours have invariably peculiar and specific temperatures, and the advance from the violet to the red ray of the prism is accompanied with a corresponding elevation of temperature. The variable changes in the chameleon are often instantaneous, though sometimes more slowly produced.

In pursuing these remarks and investigations, we were surprised and gratified to find that somewhat similar views and conclusions had been sustained by Panarolus, a Roman writer, quoted by Ogilby in his

“ Africa.” The following extracts are from the folio edition, published in 1670. Ogilby’s work on Africa is a compilation from at least forty different authors, though he chiefly relies on Bellonius in his account of Egypt.

“ Chameleon is a Greek word, and signifies ‘ a *little lion*.’ Bellonius says, they frequent about Cairo, and many other places, in the hedges and bushes : it bears some little resemblance to the crocodile ; from which it is different in colour, head, tongue, eyes, and feet : it creeps not, but walks upon all-four ; the head long and sharp, like a hog’s ; the neck very short ; and eyes, which, having no eyelid, can turn about on every side.

“ This is a sluggish and dull animal, holding the head carelessly, and the mouth always gaping, lolling out the tongue, and so catching flies, grasshoppers, caterpillars, palmer-worms, and such like ; instead of teeth, having one entire jaw-bone, indented like a saw, but useless, swallowing whole whatever food it takes ; wanting both spleen and bladder ; muting like a hawk. The back hath a hard and rough skin, beset with some few prickles ; the two fore-feet, Bellonius saith, have three claws inwards, and two outwards ; but the hinder feet three outwards, and two inwards, with hooked nails, or talons. It hath a strange and ridiculous manner of gait, or movement ; for, stretching both feet on each side at once together, and so alternately, the other makes a shuffling gradation, one shoulder jetting foremost, the other outstepping that, with a continual untoward *hank* and *loose*, that it makes spectators laugh, as if it were a match which side should come first to the goal. But he is so nimble in running up trees, that he seems rather to fly ; wherein he makes great use of his tail to lay hold on boughs, especially

in coming down; whence we may gather, that the chameleon more frequents trees than ground. Nor give the motions of the eyes less cause of comical admiration; for he does not as other creatures, who turn both eyes at once after the same object, but, something like our squinters, not only looks two opposite ways at once, but more, seeing right forward with one eye, and looking up with the other aloft; another while to the ground with one, and sideling with the other: but, which is yet stranger, it will draw one eye to its back, and make a survey behind, while the other takes a prospect forwards. They make at their meals also merriment, neither picking as fowl, nor chewing like cattle, nor sucking like lampreys and leeches; but with an odd and sudden flutter of the tongue, shot out near a hand's breadth, ingurges the caught prey in a trice. This member being nothing else but a hollow pipe, fleshy and spongy, wherein are some sinews easier to shut together than a gin or trap, because those nerves proceeding from the *os hyoides*, and running through the cavity, draw the same, after expansion, back again, with its prey sticking to a glutinous stuff, wherewith it is covered. This refutes the opinions of the ancients, who believed the chameleon lived by air; whereas, in truth, it lives by such received nourishment as we have declared.

“ It appropriates to itself another peculiar quality, in the opinion of some old writers, who deliver that the chameleon changes colour according to the several objects presented; first in the eyes, then in the tail, after that in the whole body. And this alteration of colours many authors conjecture, and, among others, the Roman Panarolus affirms, to proceed from the *systole* and *diastole* of the heart, which, according to sensibility of heat or cold, beats quicker or slower;

the quicker striking a redness, whereas the slow reduces him to his own natural ash-colour; for it retains that hue even after death, though a little paler."

The following is an amusing conceit, as Dr. Grew would call it: — "If the chameleon at any time see a serpent taking the ayre, and sunning himself under some greene tree, he climbeth up into that tree and setleth himselfe directly over the serpent, then out of his mouth he casteth a thred like a spyder, at the end whereof hangeth a drop of poyson as bright as any pearle; by this string he letteth downe the poyson upon the serpent, which lighting upon it killeth it immediately. And Scaliger reporteth a greater wonder than this in the description of the chameleon; for he sayth, if the boughes of the tree so grow as the perpendicular line cannot fall directlie upon the serpent, then hee so correcteth and guideth it with his fore-feet, that it falleth upon the serpent within the mark of a hayres breadth." *

The new view of the phenomena of the chameleon presented in the preceding pages might receive elucidation from many analogical arguments. When the mind is surprised by the tribute due to loveliness, and the circulation becomes thus affected, the conscious rose instantly blossoms on the cheek of beauty. The hectic flush on the cheek — the vermillion lip — the pale ensign of the lily where the rose was once enshrined — all concur to show that the colours thus displayed on the exterior surface are a faithful index of the varied movements of the circulating mass. The passions of the mind affect the circulation of the blood, and paint the visage. Lord

* Topsell, p. 117.

Byron has finely described the glow of youth and beauty, as affected by the passions of the soul: —

“ Her cheek all purple with the beam of youth,
Mounting at times to a transparent glow,
As if her veins ran lightning.”

Tasso as well describes the contest of the rose and lily on the features of the beautiful Armida: —

Dolce color de rose in quel bel volto,
Fra l'ivorio si sparge, e si confonde
Ma nella bocca, ond esce aura amorosa
Sola rosseggia, e semplice la rosa.

Thus, too, in inferior creation, the buffalo and other quadrupeds are violently excited by any thing *red*. When the male turkey is irritated, and struts about in all the mimic pomp and pantomime of offended pride, the *caruncle* of the forehead relaxes, and this, with the naked parts of the head and neck, mount up from *blue* to an *intense red*.

Mr. Forbes, in his “Oriental Memoirs,” adverts to the marked antipathy which the chameleon expresses to a *black* surface. When forcibly brought before a black board suspended in the room, it would tremble violently, and assume a black colour. This it carefully avoided, and when a black hat was presented to it, it shrunk to a skeleton, and became as *black as jet*, and an excitement in the animal analogous to *terror* in the human species might be deemed capable of producing such a change. The most singular effect of terror in the human species, as far as our knowledge goes, is that recorded in the “Journal de Médecine pour l’an 1817.” It occurred at Paris, in the Hospital of the “Salpêtrière.” A female, of advanced age, was

so affected with horror, on hearing that her daughter, with two children in her arms, had precipitated herself out of a window, and were killed on the spot, that her skin, in a single night, from head to foot, became *as black as that of a negro*; the change continued permanent. In that remarkable phenomenon, proceeding from a cardiac disorganisation, wherein black and red blood intermingle, the skin, in consequence of a partial and incomplete circulation, is *blue*, which proves that the blood can develop and sustain a specific dye on the cutis.

We cannot conceive a finer illustration of our view of the case than the brilliant mockery of vision displayed in the dying dolphin, as life ebbs through the orifice of the bleeding wound, thus clearly shown to be dependent on the flux and reflux of the blood. Falconer has described the phenomenon in all the philosophy of poetry. We have been informed by an eye-witness, that the tints displayed in the dying dolphin increase remarkably in brilliancy and beauty, progressive to the terminal line of life.*

The colour of the *iris* in the eye may resolve itself into a different question, but it is certainly connected with some characteristic feature of this strange microcosm. The fine *blue* eye, for instance, of the sprightly

* The following curious anecdote was communicated to us by a gentleman now in His Majesty's dock-yard at Devonport, as a fact of which he was an eye-witness. A dolphin, presumed to be a female, was caught on the line, while the ship was passing rapidly through the water: in a little time another dolphin was perceived to seize it by the tail, and, after fruitless efforts, and much tugging, finding it in vain, the fish swam round to the line, snapped it in sunder, and thus liberated the captive. In all probability, this heroic deed was accomplished by the *male*.

gazelle, introduced with such simple and beautiful pathos by Moore in his *Lalla Rookh*: —

“ I never loved a dear gazelle,
To glad me with its dark blue eye,
But when it came to know me well,
And love me, — it was sure to die.”

We have an analogous phenomenon in the case of a peculiar variety of the *Bos taurus* from Africa, described in the Magazine of Natural History.* The general aspect of the animal is mild and docile, except when irritated, and this finds its expression in the eye. The iris is naturally of a pale blue colour, but when the creature is excited it varies from a very pale blue or lilac to a deep crimson.

The views now submitted appear to us to be sustained by such forcible testimony that the evidence seems almost irresistible.

How diversified the interest and beauty which every where pervade the loveliness and grandeur of the creation of God! And what sublime pleasures are often sacrificed by the non-observance of the wonders of creative Omnipotence!

* Vol. i. p. 113.

*Never marter a dear Gazelle
To open with its soft Black eye*

CHAP. III.

ASCENT OF THE SPIDER. — IMPORTANCE OF THE MINUTIÆ OF CREATION. — CURIOUS HABITS OF PECULIAR SPIDERS. — ASCENT OF THE SPIDER OBSERVED. — GENERAL REMARKS CONNECTED WITH IT. — THE ASCENT CONSIDERED AN ELECTRIC PHENOMENON.

IF the views of the entomologist reach no higher than the collection of a cabinet of lepidopteraë, or the technicalities of mere nomenclature, we may consent to praise his diligence and laborious research, but must withhold our meed of approbation to the soundness of his views as a naturalist. Entomology, confined within limits such as these, is a dull, worthless, and contemptible study.

This branch of natural history, however, has a wider range and nobler field of usefulness; and though some pseudo-philosophers have sneered at the diminutive creatures thus contemplated, they show but the feebleness of their own understanding. Insulated, they may occasionally appear of little note, but with a commission from above, become “as the armies of the living God.” The contemptible moschito may drive man to madness, and the *zimb* of Chaldea make even the rhinoceros tremble and flee before it. An army of locusts, denser than the storm-cloud, and compassing an extent of many miles, may lay waste, in a few short hours, the blossom and promise of the year, and mercilessly consign the myriad population of a vast

empire to pestilence and famine, and all the “bit-
terness of death;” in its ravages, mock the devas-
tations of Turks, Saracens, and Tartars, and claim
mightier trophies and triumphs than an Attala, an
Alexander, or a Genseric.

The colour that vies with the brightest ray of the
rainbow, we owe to a species of *coccus*. Silk, once
balanced for its weight in gold, we receive from a
moth. What is sweeter than honey? — an insect pre-
pares it. These are only a specimen of the benefits
we receive from the insect tribe; but they exalt them
in the scale of usefulness.

By studying the natural history and economy of
insects, we shall obtain more enlarged views of the
beneficence and omnipotence of Heaven; and in their
protection and preservation, we shall perceive interest-
ing examples of that Providence which watches over
the minute as well as the vast and gigantic in the
universe: nor is it less delightful to contemplate the
humble *lolium arenaria* guarding the confines of the
sea, by interlacing and intertwisting the sod that
enamels its shore, as if commissioned by Providence
to say to its world of waters, “Hitherto, and no farther,
and here shall thy proud waves be stayed,” — than to
contemplate the “moon walking in brightness” amid a
thousand twinkling worlds of light. If *size*, indeed,
were the touchstone of excellence and the standard
of appeal, then, as has been well observed, would “the
horse be more excellent than his rider.”

To the natural historian none of the works of Infinite
Wisdom can be an object of indifference. Size is a
merely comparative term, and is secondary in consi-
deration. Loftier views than the measure of a portion
of supplied space engage attention, and the whole
mental powers ought to be subordinated to the admir-

ation of HIS works, who is “maximus in maximis, maximus in minimis.”

It seems to us probable, that the phenomena of the ascent of the spider will be found ultimately connected with the meteorology of the atmosphere ; and the observation of its curious habits lead hereafter to some useful practical results.

Among all the phenomena presented to the study of the entomologist, there are few to be found more interesting than those that are met with among spiders. Haafner, in his *Pedestrian Journey through Ceylon*, thus describes the horned spider : — “Its brown rough body was more than six inches round, and its claws, the thickness of a quill, held a lizard, the flesh of which it was greedily devouring. I could plainly see its fiery eyes rolling in its head.” The Barbary spider carries its young in a pouch or bag, like the opossum or kangaroo ; and the young spiders, after being nursed and nestled there, sometimes destroy their parent, while the female frequently kills her mate.* The family of the *aranea*, or spider, presents a display of cruelty and cunning seldom exceeded among the most ferocious of insect tribes ; yet their history is fraught with the interest of much curious ingenuity, and there are phenomena connected with it which may well claim attention. They are tigers in ento-

* Though a cruel race, the female is careful of its young. The sac, or bag, which contains the ova, is a tissue, impervious to water, and is their constant companion wherever they go. Some keep incessant watch over their young. We remember to have witnessed this most interestingly exhibited in the case of one whose nest we rent asunder, and disturbed the included young ; the female never stirred from the spot, but, regardless of self-preservation, endeavoured to rally them round her, and restore tranquillity and confidence.

mology; yet their attachment to, and affection for, their young command our admiration: one, for instance, chose rather to be buried alive with her *ovarium*, than relinquish the possession of it to an ant lion. Its silken cocoon of ova is, to the spider, its all; it is its constant accompaniment, and it will part with life sooner than resign this invaluable pearl. They may be tamed, too, and are not insensible to the kindness that supplies their wants.

Spiders, it would seem, are not entirely without their value in the arts: Bon, a Frenchman, obtained several pairs of stockings from the webs of a particular kind of spider, and had suggested their cultivation; the idea, however, was finally abandoned, as they made war on each other. In the British Museum, if we remember right, is a small painting, the canvass of which is a spider's web. A species of red spider is said to have been used abroad in dyeing; and in this country there is a minute species, with a brilliant scarlet dress, which we have often met with on the walls of Chester, though neither this nor the *murex* is likely to supplant the cochineal. The Bahama spider is described as two inches long. "He hath two strong black shining teeth, like crooked claws, standing parallel, and with their points downward, above half an inch long by the bow. These teeth, being set in gold, are used by some for tooth-picks!"*

The *mygale avicularia* of South America is about two inches long; and we are assured by Straoss that it certainly sucks the blood of the humming bird, and in all probability entraps it in its web. Among the "Rarities of Gresham College," there is stated to have been

* Grew, quoted from Pen. Nat. Hist.

“ the web of a Bermuda spider. It is as strong as to snare a bird as big as a thrush : ’tis here wound upon a paper, like new silk.” We remember to have found, in our rambles through the Pontine marshes, a spider’s thread, white as snow, and like ravelled silk, of considerable cohesion. In the Magazine of Natural History we have described a beautiful conical structure discovered in South America, and, in all probability, the workmanship of the *mygale avicul*. The *mygale cementaria*, a native of Jamaica, burrows in the earth like a rabbit, forming a cylindrical cavity from twelve to fifteen inches in depth : like the upholsterer bee, it lines its walls with silk tapestry ; it also constructs a valve or trap-door of silk, opening from within, and closing the aperture by its own weight. In the fens of Norfolk may be found a large spider, which forms a *raft* for catching its prey : this raft is constructed of a ball of weeds, and is about three inches in diameter : the insect takes possession of the “ emerald isle,” and thus commits itself to the stream. The *aranea aquatica* constructs a subaqueous abode by attaching threads to the stems or leaves of aquatic plants, and smearing the interstices of the meshes over with some transparent glutinous matter, similar, we think, to that used by the *caddis worm* in the construction of its leafy dwelling : the diving bell is at length finished, and the introduction of air, brought from the surface and introduced beneath, expels the water ; and here, in its crystalline subaqueous domicile, it devours the prey at leisure it hunts for sometimes on land, and where none of its congeners will care to follow and contend for possession. This curious fabric is filled with air precisely in the same manner as the chemist supplies his deflagrating jar or bell-glass over the shelf of the pneumatic cistern ; and

an aërial structure is reared within “ the world of waters.” It is shaped somewhat like a pigeon’s egg, divided, is about this size, and, when illuminated by the sun-beam, shines like a silvered mirror. In a corner of this curious abode repose the *ova* of the insect, wrapped up in a silken cocoon, and tended by the female with incessant watchfulness.

The *aranea geometrica* spins a very beautiful web ; and it is worth while contemplating its operations on a calm summer evening, in the snug corner of some window, hedge, or paling : an old Latin poet has said, —

“ Nulla mihi manus est, pedibus tamen
Omnia fiunt ;” —

and, in allusion to the spider, the naturalist of the sacred volume has observed, “ The spider taketh hold with her hands ;” and in these curious weaving operations, it is interesting to observe how well the tibia and tarsus supply their place. Radii diverge toward the periphery of several concentric circles, and these will be found to be more polished and glassy than those threads which intersect them, and are last woven. The spider having collected the threads emerging from the centre, retires to his hiding-place in one of the angles, and holding these threads by its tibia and tarsus, as a coachman does the reins, the vibration communicates information whenever an unfortunate and unwary insect is entangled. The particular thread of the web is thus easily discriminated ; and though the spider may be effectually concealed, and invisible to the victim, it will pounce instantly to the spot, glancing along the vibrating lines.

That this curious tribe of insects may present occasional phenomena connected with the meteorology of

the atmosphere, our researches on the *aranaea aëronautica* would seem to prove, and the manner in which some spiders carry on their operations confirms the conclusion. If the weather is likely to become rainy, windy, or the like, the spider fixes the terminating threads by which the entire web is suspended, unusually short, and in this state awaits the impending change. On the other hand, if these threads are discovered to be long, we may conclude that it will be in that ratio serene, and continue so for about a week or more. If spiders be completely inactive, rain will likely follow; but if, during the prevalence of rain, their wonted activity is resumed, it may be considered as of short duration, and to be soon followed by fair and constant weather. It has been also observed, that spiders regularly make some alterations in their webs every twenty-four hours, and we feel persuaded that this is the case: if these changes are observed between 6 and 7 o'clock, P. M., they indicate a clear and pleasant night. It is really interesting to observe, in a fine summer's day, the threads that fan and flutter in the breeze from the trees and hedges; and they are often stretched across the road from hedge-row to hedge-row, particularly in a morning or evening.

The ascent of the wingless spider into the atmosphere, is a fact unquestionable and unquestioned. Linnæus, Shaw, Donovan, and others, throw no light on the subject, nor indeed attempt a solution. In the *Edinburgh Review*, in reference to Kirby and Spence's *Entomology*, it is remarked: — “The flying of certain spiders, by means of their webs, is not the least extraordinary mode of motion possessed by spiders; nor, in truth, is it very intelligible, although the fact itself is unquestionable. In ordinary cases, the spiders spin their threads slowly from organs adapted to that end,

perforated with numerous holes, so that each thread may consist of many thousand filaments. The flying spiders, on the contrary, can dart out the thread in a straight line for many inches, in any direction, and then in some unknown manner they follow it. In these cases, when the animal and his chariot are wafted away together by the winds, there is no difficulty. Our authors have thrown no additional light on this difficult subject."

The gossamer-web was formerly believed to be a tissue of " scorched dew ;" thus Spenser, —

" The fine net which oft we woven see
Of scorched dew."

Even Dr. Hooke said that the gossamer only " much resembled a cobweb," and that " the great white clouds that appear all the summer-time might be of the same substance."

While Swammerdam and De Geer ridiculed the idea of the flight of spiders, Dr. Hulse seems to have more particularly observed the property which certain spiders possess of propelling their threads into the air. Dr. Martin Lister discovered that spiders were wafted aloft on this airy vehicle ; and, in fine weather, found, more than once, a spider which, from its flight, he called " the bird : " he afterwards noticed that the insect, by elevating the anus, darted a thread from thence, and thus rose into the atmosphere. From the highest point of the Cathedral of York, Dr. Lister beheld the gossamer-webs floating far above him. Mr. White of Selborne confirms this account : a spider darted off from the page he was then perusing, and, though the atmosphere was tranquil, its ascent was rapid ; and it has been considered that this property is not peculiar to one species, but that several

spiders, when young, can so raise themselves in the air. Dr. Lister conceived that spiders, in their transit through the atmosphere, could coil up their threads, and descend *ad libitum* from their aërial excursions, by altering in this manner their specific gravity.

We are not aware that any have attempted to describe the gossamer-spider as a distinct and peculiar species, Bechstein and Starck excepted; but they seem to have got hold of different species: thus, the former describes it as being the size of a small pin's head, having eight eyes disposed in a circle, body of a dark-brown colour, and light-yellow legs; while that of Starck extended more than two lines in length, having eyes in the form of a square, two on each side, in contact with each other; thorax of a deep-brown colour, with paler streaks; the under side of the abdomen of a dull white, and a dark copper-brown colour above, with a dentated white spot running longitudinally down the middle. Dr. Starck imprisoned several of these under a bell-glass, on a grass-plate, and he tells us they existed two months without food, though they took water greedily. Mr. White observed a remarkable phenomenon on the 21st of September, 1741. Early in the morning the whole country was enveloped in a coat of cobweb, wet with dew. His dogs, on a shooting excursion, were blinded by them: a delightful day succeeded; and, at nine o'clock A. M., *a shower of these webs* fell, (not single threads, but formed of flakes,) some nearly an inch broad, and five or six inches long, and continued to fall during the entire day. Baskets-full might have been collected from the hedges; and, from the velocity of their fall, it was evident they were considerably heavier than the medium through which they descended.

The small spider with which these remarks are connected has its eyes disposed in a *circle* somewhat elongated ; the body and legs, examined with a lens, are hairy, palpi bifid, and protuberant at the end ; tarsus, forked or clawed ; legs, &c. somewhat translucent ; abdomen and thorax glossy, and of a dark ferruginous colour ; anal processes, three ; the femur and tibia have each two articulations. Mr. Kirby writes us, that he thinks the *arana obstetrix* of Starck is that referred to : but the one described by Starck under this name is *striped*, and the eyes are arranged in the form of a *square*, which are certainly sufficient distinctions. This approximates more nearly to Bechstein's *arana obstetrix*. We shall take leave, therefore, to call it ARANEA AËRONAUTICA, because, under the name *arana obstetrix* the German naturalists describe two entirely different insects. The chief reason, however, for our proposing the assigned name is the fact that its ascent and movement in the air are *essential to its existence* ; and the numbers that occur in the atmosphere are such as sufficiently to account for the gossamer, and its beautiful and interesting phenomena. It cannot, therefore, be doubted, that those threads which glisten in the sunbeam, and float in the air from the hedges and hedge-rows, and the reticular tissue on grass, which, when sparkling with dew, refracts so beautifully the tints of the rainbow, are the work of the aëronautic spider.

Connected with this question, we may mention a phenomenon similar to that mentioned by Mr. White, and witnessed on the 16th of September, 1822, at Bewdley, in Worcestershire. Between the hours of 11 A. M. and 2 P. M. the whole atmosphere seemed to be a *tissue of cobwebs*, which continued to fall in great numbers, and in quick succession ; the temperature

was 72° F. Some of these were single, others branched filaments, occasionally from 40 to 50 feet in length ! others were woolly films, or flocculi : some fell slowly, and others more rapidly. This was first noticed in the market-place at Bewdley ; and, on repairing to the adjoining fields, we found the same phenomenon, and our clothes were most curiously invested with a network of spiders' threads. In a communication to the Rev. J. J. Freeman of Kidderminster, now a Missionary in Madagascar, we remarked this circumstance ; and the following is an extract from his letter to us, dated 18th of September, 1822 : " The fall of cobwebs was also observed here on Monday. A gentleman told me he was obliged to wipe his face several times while walking in his garden about 12 or 1 o'clock, such quantities continued to fall on him." On the 19th of July, 1822, the yeomanry, at 1 o'clock P. M., were drawn up in the market-place at Kidderminster, to fire a *feu-de-joie*, which had the effect of bringing immense numbers of this spider from the aërial regions : we picked up a considerable quantity from the pavement, when the yeomanry had withdrawn, and several took refuge on the table where we were reading, near the window of the hotel, then partly open.

We have stated that a free and unrestrained privilege of ascent into the atmosphere is a condition essential to the very being of these remarkable insects. The *blaps mortisaga*, it is known, will live three years shut up, and deprived of food : we have kept the *aranea diadema* two months under similar circumstances : indeed this insect has been preserved alive upwards of a year, confined and without nutriment. The *aranea aëronautica*, however, we find is impatient of confinement, and will *die*, when imprisoned, sometimes within twenty hours, or at most in a few days. .

We introduced one of the aëronautic spiders under water ; but it did not appear injured ; and when withdrawn, soon let itself fall by means of a thread. Placed on water, at 66° F., it remained on its surface, without attempting to escape by the propulsion of a thread, taking repeated springs forward, then receding, and patting the water rapidly with its tarsi, in the manner of the squirrel. In water at 67° F., it was quiescent : during repose at the bottom of a tumbler of water, there issued from between the palpi an air-bell, which, expanding, carried the spider to the surface ; the aërial appendage thus diminishing the specific gravity, and affording a striking elucidation of the habits of the *aranea aquatica*. An aëronautic spider being put into water at 94° F., remained at the bottom of the vessel, sometimes at rest, sometimes locomotive. At length it projected a thread upward, and by that means wound itself, resting at intervals, to the surface of the water : at the close of the experiment, the temperature had fallen to 86° F. One of these spiders, by candle-light, darted instantaneously a thread to the ceiling of the room (eight feet high) ; it described an angle of about 80° with the horizon. By means of the combined act of the tibia and tarsus, the thread was made to spin with great rapidity on its axis ; during this period it moved gradually toward the vertical plane, and, being thus highly twisted, formed a stronger medium of escape.

On one occasion we were making some experiments with an aëronautic spider, during a warm day, and brilliant sunshine, about noon ; the door of the room was ajar, and the insect, in the act of propelling its threads in all directions, when it suddenly darted one toward the door, in the direction of the influx-current, perfectly horizontal, and in length fully ten feet : the angle of vision being particularly favour-

able, we observed an extraordinary *aura*, or atmosphere round the thread, which we cannot doubt was electric. *

We began our experiments and observations on this curious subject on the 2d of June, 1822: one of these spiders alighted on us, and glanced off from the hand with considerable rapidity: thermometer 77° in the shade. It is impossible to walk in the fields without being saluted by several of these insects: they will be chiefly noticed by alighting on the hat, and descending by a thread before the face: in this way they are easily caught, as they will drop into a chip-box, and may be secured. When swinging from a support, they will soon be perceived to ascend from the perpendicular into the horizontal plane, at each ascent projecting a thread into the atmosphere; and at length the insect breaks from its anchorage, and ascends. Sometimes aëronautic spiders will take their flight immediately from the surface on which they alight, if the day be warm and sultry: but they generally descend to from 6 to 18 inches, perhaps the better to *insulate* themselves, and that, suspended by a pliant thread in free space, they may more freely propel their threads into the atmosphere. Not unfrequently the propulsion of a solitary thread will bear them aloft; but the air must then be very warm, the sunshine bright, and the electric character of the atmosphere considerable. Sometimes the ascent is so rapid that the eye cannot trace it; at other times slow and majestic. Occasionally the ascent is quite vertical, and at other times the insect sails on the bosom of the air, either in the horizontal plane, or at angles more or less open. It will be also found that there are *particular seasons* of the year best calculated for this singular exhibition: spring and

* A similar phenomenon appears to have been witnessed by "Carolán," and recorded in the *Annals of Philosophy*.

autumn are these periods. In summer we have found it sometimes impracticable to determine their ascent: they have detached themselves, after several vibrations, and fallen to the ground. On one day (May, 1823,) this remarkable fact was proved in the case of numbers. The insect seems to be sufficiently aware when the threads are buoyant, and perhaps the temporary suspension in the horizontal plane may communicate this information: aëronautic spiders make their appearance early in the season.

Several circumstances concur to show the phenomenon of ascent to be *electric*: the propelled threads *do not* interfere with each other; they are divellent, and this divergence seems to proceed from their being imbued with similar electricity; and the *character* of that electricity appeared to us to be an interesting subject for subsequent research. When a conductor is brought near the thread by which it suspends itself, but, above all, to the flocculi or balls, they are considerably deflected from the perpendicular, and the horizontal fibre is attracted by the point: when a stick of excited sealing-wax was brought near the thread of suspension, it seemed to be *repelled*; consequently the electricity of the thread is *negative*. The descent of the thread is instantly determined by bringing over it the excited sealing-wax. On the 3d of July, 1822, at 4 P. M., thermometer 66° F., when two aëronautic spiders, on separate threads, were brought near to each other, a mutual repulsion supervened.

In one experiment made, the ascent of the insect was so slow and tranquil, from the humidity of the lower atmosphere and wetness of the terrestrial surface, that I could easily catch it by following its progress: it moved in a plane parallel to the point of departure. On the 4th August, 1822, at 3 P. M., thermometer 66°, the ascent was slow and beautiful, the

little aëronaut rising regularly in the vertical plane. It was distinctly perceived, from the steady fixation of the eye, and favourable angle of vision, until it had attained an elevation of at least 30 feet, and was finally lost in the vanishing point of elevation.

A variety of phenomena unite their testimony in favour of the conclusions formed, and from what we consider the direct method of induction. Were the thread not electrical, we may be asked how it could be propelled through the atmosphere in the vertical plane, and remain there, contrary to the laws of gravitation? It is indeed remarkable, that the threads should always remain in the precise plane in which they are propelled, nor swerve from it. The constant relative separation finds an analogy in similarly electrified pith-balls, or the divergence of the filaments in a glass plume, placed on the conductor of an excited electrical machine, and the electric state of the atmosphere will always be found to modify the phenomena. The transit of the thread through a resisting medium, without its suffering deflection in its path, seems to prove it imbued with a power superior to, and able to overcome, that resistance.

“ I saw a spider swinging in the air,
 And said, ‘ Ambitious reptile, thou resemblest
 Our worldly proud ones ; and, although thou tremblest
 At every little gust, canst not forbear
 To mount aspiringly. For what? To fall
 Humbled, as other soarsers fall.’ But, lo !
 I looked, and saw a film, minute and small,
 Which the adventurer had suspended so
 That his retreat was sure : and then I said,
 ‘ Thou art *not* like the soarsers of the world ;
 For thou, if from thy seat of glory hurl’d,
 Hast made thyself secure by this light thread,
 Which from thy height will light thee safe again : —
 O, thou art wiser far than prouder men ! ’ ” BOWRING.

CHAP. IV.

ASCENT OF THE SPIDER CONTINUED. — GOSSAMER THE WORK OF THE SPIDER. — NECESSITY OF DESCENT, ETC. — PROPULSION OF THREADS. — CONJOINED OPINION OF MR. BLACKWALL AND MR. RENNIE. — THE MECHANICAL IMPULSE OF AERIAL CURRENTS QUESTIONABLE AS TO EFFICIENCY. — ASCENT INTO THE ATMOSPHERE ASCRIBED BY MR. BLACKWALL TO THE IMPULSION OF HEATED EMANATIONS FROM THE GROUND. — FACTS THAT SEEM TO CONTROVERT THIS OPINION. — FORMER VIEWS REITERATED. — BENEFICENT PURPOSE SUBSERVED BY THEIR ASCENT.

THE Germans connect with the gossamer in autumn an allusion to the transient season: it is called “the flitting summer.” These films that often pervade the atmosphere have been called, in France, the “Virgin’s” threads — while we give it to the sylphs: —

“Lovers who may bestride the gossamer
That idles in the wanton air.”

That the “sea of gauze covered with dew,” which decorates our meadows, and sparkles in the morning with a summer or autumnal radiance, is the laborious structure of the *bird spider*, is beyond a doubt. We have seen more than a dozen in the space of a few inches; and Starck says that twenty or thirty are often found on a single stubble: “he collected 2000 in half an hour, and could easily have got twice as many had he wished it.” In a fine autumnal afternoon we have

seen a newly ploughed field one tissue of beautiful gossamer, and woven in the course of little more than two hours. This reticular web intercepts the dew; and its pearly drops, of extreme minuteness, refract the solar ray, and glow with all the beauties of the prism. There can be little doubt that these are *carnivorous*, like the rest of the species, and that they obtain their food at very great elevations, and at altitudes, we conceive, where they could not find moisture; they must of necessity therefore alight at night, weave their web to entangle the dew, for this they greedily absorb, and without which, if our observations and experiments be correct, they *could not exist*. At first sight, it might be supposed, that there exists no necessity for their weaving such a reservoir for moisture; but its importance will appear when we consider that the leaves of plants *secrete carbonic acid gas* at night, and therefore the dew that condenses on foliage, being necessarily saturated with this gas, might prove a nauseous and fatal beverage to these creatures.

The buoyant principle of these aëronauts has been the subject of much speculation and curious conjecture. "Its Creator," says the author of "The Natural History of Insects," in that elegant little work, the "Family Library," "hath laid for it a path in the atmosphere; and after this manner, though the insect itself be heavier than the air, the thread that it spins from its bowels is *specifically lighter*. This is its *balloon*. The spider, left to itself, would drop to the ground; but being tied to its thread, both are supported." Now, if this supposition of the ingenious author were proved to be correct, the ascent of the insect into the atmosphere admits of an easy solution, and there is no more difficulty in the case than in

that of the ascent of a balloon; and Mr. Blackwall's hypothesis of heated currents becomes at once superfluous and unnecessary: but it does occur, that the thread is *not* specifically lighter than the air, but so much heavier, that it immediately falls to the ground, unless *electrified*, when it floats, or is borne up by some other buoyant principle. "It is now generally admitted," says this able author, "that several kinds of spiders have a power of darting out a thread in any direction, and to a comparatively great distance. The mechanism, however, of this extraordinary effort is not at all understood." This is an opinion characterised by a laudable philosophical caution; and he also expresses a doubt, notwithstanding what Mr. Blackwall has advanced on the subject, in his paper published in the Linnæan Transactions, whether the gossamer of the morning is ever carried up into the air. Indeed a suspicion and scepticism may be very naturally indulged on this question, since the gossamer-web seems to remain just as it was, though not so visible to the eye, after the entangled dew has exhaled from it in the sunbeam; and, indeed, so firmly cemented to the spikes of grass are those threads, that they cannot be detached entire.

There are two distinct phenomena connected with this little aëronaut, which may be considered independently of each other. The first is, the power of propelling the threads into the air, and the principle by which it is excited; and the second, the cause which promotes its ascent. Mr. Blackwall considers, in reference to the first, that "air sensibly agitated" is necessary to the projectile power, when the thread is then "*carried out* in a line." We confess, however, that to us it is not quite so obvious, how this effect should be produced in the "wind's eye" of any such

current, "either naturally or artificially produced." It is also assumed, that "this velocity is equal, or nearly so, to that with which the air moves;" though such a ratio of correspondence, traced to its exciting cause, is not so clear. However, this observer persists in "affirming that, in motionless air, spiders have not the power of darting their threads through the space of half an inch;" or, in other words, we infer, of not being able to "dart" their threads at all; and Mr. Rennie, in kind and faithful echo, adds, "we are quite certain that it cannot throw out a single inch of thread without the aid of a current of air." The latter is of opinion, that "the globules, being carried up by the current of air," are thus "drawn out into a thread:" but how this can be effected *counter* to such a current, is not so easily imagined. However, Mr. Rennie, on "producing a stream of air, by blowing gently towards its position," — "had the pleasure of seeing a thread streaming out from them" (the "spinnerets"); and he was "convinced" also, "that it was the double or bend of the thread which was blown into the air:" and then follows a "reason" for the spider's doing so. The premises on which these conclusions are founded do not appear to us by any means quite so satisfactory as they do to these observers. Some spiders being imprisoned under a bell-glass, projected no threads whatever; and it is thus concluded they were *unable* to do so. This opinion, however, is scarce warrantable. It is not doubted that these insects are sagacious creatures, and might in this case, also, have a "reason" for not making the useless attempt: they surely *saw* that a crystal hemisphere bounded their pathway, and that their imprisoned space was circumscribed; and all this cunning might be reasonably assigned to them, without extending their sagacity to the amount of

Mahomet's spider, which insured the safety of the flight of the prophet of Mecca.

Even on the supposition that such a current is essential and necessary, it can only be regarded as an *exciting cause*, rousing the insect, or imparting the power to evolve its thread. The most interesting part of the question is, whether it acts in a merely *mechanical* capacity, or whether this excitement be something more, and connected with a power superior to what these views suppose. Bennet and other electricians have long ago proved, that the impulse of air on a delicate electroscope invested it with electricity; and this, if proved in the one case, must of necessity be admitted in the other. In the Mediterranean, Mr. Black appears to have ascertained that winds, or currents of vapour of some continuance, are negatively electrical, and the land breeze in a state of positive electricity. It seems deducible, therefore, that an electrical excitement may be the consequence of such currents; and it seems equally obvious that insects are sufficiently sensible to atmospheric electricity. Thus Huber seems to have proved, that the secretion of honey is intimately connected with electricity; and that bees are far more active and laborious before a storm, and when the wind is south and the air warm and humid, than at other times: and Kirby and Spence also observe, that "insects seem particularly excited by a high electric state of the atmosphere, and are then found more numerous on the wing than at ordinary periods, and towards evening; and that, some time before the storm comes on, various kinds may be then seen, that do not appear at ordinary times: but immediately before the storm, all disappear."* D'Isjonval observes, that "animals are

* The extraordinary activity of the swallow on these occasions is a manifest proof.

affected by natural electricity; but no one more than myself and my spiders." He had found, by repeated observations, that the length of the spiders' threads corresponded with the electrical state of the atmosphere: for in wet and stormy weather they were short, and in fine weather were proportionally long. Now, as there *may* exist *other causes* sufficiently powerful to act as excitants, as well as a current of air, the question remains as it was: besides, apart from an effect analogous to electrical excitement, the *modus operandi* of a current of air seems most obscure and perplexing.

There can, we think, be no doubt naturally entertained on the subject, that spiders *can* project their threads in motionless air, peculiarly circumstanced. A ray of solar light, for instance, will do it; and the insect will, in this case, sometimes dart out a thread many yards long, perfectly vertical; and, with the velocity of an arrow, and an ascent equally rapid, is lost in a twinkling to the eye of the observer. Mr. White has the following remark: "Last summer one alighted on my book as I was reading in the parlour, and running to the top of the page, and shooting out a web, took its departure from thence. But what I most wondered at was, that it went off with considerable velocity, in a place where no air was stirring, and I am sure I did not assist it with my breath; so that these little crawlers seem to have, while mounting, some locomotive power, without the use of wings, and move faster than the air, in the air itself." This phenomenon it has been our fortune frequently to observe. The phenomenon recorded by Mr. Blackwall on the 1st October, 1826, accompanied by "a profusion of shining lines," was observed when there was "no wind stirring;" and accordingly Mr. Rennie noticed that a spider "can produce a line when there was scarcely a breath of

air." But they seem "noticeable" beings, as Wordsworth would say ; for Mr. Rennie has actually seen them "endeavouring to ascertain in what direction the wind blew, or rather, which way any current of air set, by elevating their arms, as we have seen sailors do in a dead calm!" It certainly would be a matter of difficulty to ascertain, "in a dead calm," what way the wind blows, and we doubt whether even Mahomet's spider could do this. We presume, at any rate, that the property which spiders have of shooting out their threads was much more early observed than is generally supposed. "Spiders," saith Aristotle, "cast their threads, not from within, as an excrement, as Democritus would have it, but from without, as the hystrix doth its quills." *

The ascent of this apterous insect into the air is a problem which very few have attempted to solve, and, from the difficulty attendant upon it, many have denied its possibility altogether. It seems to have puzzled Mr. White a good deal: however, the following supposition is hazarded: — "I should imagine," says he, "that those filmy threads, when first shot, might be entangled in the rising dew, and so draw up spiders and all by a brisk evaporation, into the regions where clouds are formed; and if the spiders have a power of coiling and thickening their webs in the air, as Dr. Lister says they have, then, when they become heavier than the air, they must fall." Gay Lussac considers the ascent of clouds, in the regions of air, entirely ascribable to the impulse of ascending currents, arising from the difference of temperature between the surface of the earth and the atmosphere at great elevations. Mr. Blackwall assumes the same impulsion,

* Grew.

as accessory to the flight of the spider ; but the fact proves that clouds are replenished with electricity, and the sunbeam which impinges on them may be the medium of supply : besides, the floods of heat which descend to us in the sunbeams would more than suffice to check or counteract these assumed emanations ; and in the brightest sunshine, *cæteris paribus*, the ascent of our little aëronaut will be most rapid. This is not the place to discuss the phenomena of the clouds ; but seeing that the solar ray will communicate electricity to them, and from the circumstance that ammoniacal gas, by electric influence, may be expanded into double its former volume, in all probability the elasticity of these aqueous reservoirs may be enhanced by the same means, and their buoyancy be thereby promoted. As far as we can discover, the only tangible phenomenon on which Mr. Blackwall hazards his conjecture is one perfectly *unique*, and therefore *sui generis* ; for, as far as our information or reading extends, nothing of the kind has ever been seen by any other observer ; and if this be the case, it is *possible* that it may have been a *deceptio visus*, or some anomalous occurrence. “ What more particularly arrested my attention,” says he, “ was the ascent of an amazing quantity of webs of an irregular complicated structure, resembling ravelled silk of the finest quality and clearest white : they were of various shapes and dimensions, some of the largest measuring upwards of a yard in length, and several inches in breadth in the widest part ; while others were almost as broad as long.” He proceeds to inform us that it was “ quickly perceived, these webs were not formed in the air, as is generally believed, but at the earth’s surface.” We much doubt, however, whether this intuitive perception will be equally satisfactory to

mere exotic growth of the electric movements that pervade the exalted regions of the sky.

Volcanic eruptions are always accompanied by a highly electrified state of the atmosphere. We are informed by Mr. Ronalds*, that he found in his experiments on Mount Vesuvius, in June and July, 1819, the atmospheric air *constantly* positive; the intensity increased as the sun rose, except when *influenced by explosions of the volcano*; and the variations of intensity occurred very frequently. The difference between the highest and lowest degree of intensity amounted to nearly one third of the mean intensity. These variations occasionally accompanied changes of wind, which frequently succeeded six or seven times in the course of half an hour. Signor Gemmellaro relates the following curious electric phenomenon, which occurred on Mount Ætna, on the 2d of June, 1814:—"Carbonaro, one of the guides, and the most advanced of the party, felt his hair stand on end, his forehead and face benumbed, and he heard a hissing noise: he took off his cap, and his hair became more bristled, and the whistling noise more powerful. The traveller nearest to Carbonaro also heard a humming sound, and asked the guide what it was. In the mean time they approached each other, and were pleased with the magic sound. The traveller turned to call his companion, who was at some distance, and made a sign to him with his hand: the hand, when raised, produced a much stronger sound, so much so, that moving the fingers singularly modulated it. Finally, the three persons having joined, they experienced great pleasure, as, by moving their fingers, they produced the above extraordinary effect." During the convulsions of the

* Professor Brande's Quarterly Journal, vol. xiv. p. 332.

volcanic eruption, lightnings are seen to dart their forked fires across the mantle of clouds which issue from the crater, so well described by Sig. Monticelli of Naples, in the eruption of October, 1822, when Vesuvius exhibited the magnificent spectacle of a blazing cataract of liquid fire from the flowing of the lava, while dense and dark pillars of cloud, mingled with flame, ascended to the heavens, and the lightning amidst the sable canopy displayed its mighty coruscations and scintillations, resembling “*l’ enorme e rigoglioso pino* ;”—of which we have the following particulars by Sigs. Monticelli and Covelli:— On the 22d of October, 1822, an enormous column of fire, two thousand feet high, rose from the top of the mountain, and lightning ascended from the crater, in the form of a pine, followed by numerous zig-zag flashes, which continued unceasingly to penetrate the rising cloud of cinders. Toward the middle of the night, the paroxysm of the volcano seemed to have been at its acme: the play of electricity, which embellished the elevated regions of the clouds of sand, became stronger, and acquired fresh vigour: at this moment the heavens presented a very unexpected scene; zig-zag flashes of lightning passed in such quantities, either from the border of the clouds of sand into the air, or from one cloud to another, so that the edges appeared fringed with light, similar to an electric disc, throwing off continued flashes of light. On the 23d, the continual discharge of the lightning, accompanied by awful thunder, fell on the most elevated points of the churches, houses, and trees: numberless flashes were observed to serpentize on all sides, coming not less frequently from the earth than from the heavens. The volcanic sand, which fell on the 23d and following days, was positively electrical. Prior to this memor-

able eruption, we descended into the crater several hundred feet, but are informed by a friend that, from its present condition, this is now impracticable.

We consider the *earthquake* connected with volcanic agency. The air will be found highly electrical, and immense are the distances to which its influence extends. During the earthquake at Lisbon, 1755, the celebrated St. Winifred's Well, at Holywell, suddenly ceased to flow, and continued so for three days. The late Dr. Muter, a clergyman of the church of Scotland, informed us, that, on the morning of the day of the earthquake, he and a friend were walking together on the verge of Loch Lomond; the lake was then remarkably tranquil, unruffled by the slightest agitation; the waters, however, suddenly rose eight feet above their former level, and had well nigh swept them away. The great earthquake which occurred on the 13th of August, and was renewed on the 5th of September, 1822, that destroyed Aleppo, and buried more than 20,000 of its inhabitants, extended to many other towns in Syria. The shock was felt at Damascus, and in the Isle of Cyprus. In this case the *vertical* undulations were an extraordinary feature, these being generally, if not almost exclusively, in a lateral direction. It preceded little more than a month the eruption of Vesuvius already referred to.

Before the first shock of the earthquake in Calabria, in the year 1783, many of the inferior creation evinced symptoms of terror and alarm. The fishes, in a state of stupor, came to the surface; birds screamed, as they dashed through the air alarmed; horses, oxen, &c. roared, and shook in every limb; their eyes rolled and glared with terror; in cats, their backs rose, and fur bristled up. The first shock was immediately preceded by a sultry shower: the wind howled, and the

sea rolled fearfully, and a subterranean noise was heard, like the rolling of violent thunder; and then the earth rocked, and immense districts were convulsed to their foundations; lakes and rivers suddenly appeared amid rocks and dry places; towns and villages were overthrown, and the falling ruins crushed their tenants. Throughout Calabria 40,000 persons were destroyed, and 20,000 more fell victims to the epidemics which followed. Calabria, as well as the Caraccas, has often been the scene of these tragic events. In 1812, from information communicated to us by a native of Calabria, earthquakes had almost a diurnal return, and immense rents were formed by the earth opening beneath. Father Kircher witnessed the fate of Euphemia. The eye being directed thither saw nothing but clouds and darkness; the vapours at length rolled away, and presented the frightful picture of a dark, dismal and pestilential lake where the city of Euphemia once stood. Extensive, indeed, are the ramifications of these convulsive throes. During an eruption of Hecla, upwards of twenty years ago, we are informed the atmosphere in that direction seemed to be affected: it appeared to consist of denser materials, and of an orange-red colour. Mr. White, in his "Natural History of Selborne," says, "the summer of the year 1783 was an amazing and portentous one; for, besides the alarming meteors and tremendous thunder storms that affrighted and distressed the different counties of this kingdom, the peculiar haze or smoky fog that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appearance, unlike any thing known within the memory of man. — The sun at noon looked as blank as a clouded moon, and shed a rust-coloured ferruginous

light on the ground and floors of rooms, but was particularly lurid and blood coloured at rising and setting." Now during these phenomena witnessed in Britain, Calabria was convulsed to its centre, and Sicily torn by earthquakes, while on the coast of Norway a volcano emerged from the sea, like that witnessed by the crew of the *Sabrina* off the Azores, but which we believe has since sunk.

CHAP. VI.

PHENOMENA OF VEGETATION. — DUTROCHET'S THEORY. — ANIMAL ELECTRICITY. — ASCENT OF THE SPIDER.

IT seems highly probable that the entire chain of the phenomena of vegetation is influenced by electricity, or electric currents. Electric gleams were first observed by the daughter of Linnæus to play in the evening on the flowers of the Indian cress; and the attachment of dew to the points of leaves appears connected with the same principle.* The recent beautiful theory of Dutrochet seems to confirm these observations. According to our author, the roots absorb water, with such soluble matter as may be present; this flows upwards to the leaves, through the *lymphatic tubes* of Decandolle, and which are found both in the soft and hard wood; this fluid solution as it ascends absorbs *laterally* a portion of the already elaborated and assimilated sap, to form the leaves. Being carried up to the leaves in spring, the sap there undergoes a chemical change, evolving oxygen by day, and carbonic acid gas at night: thus assimilated, it again returns, descending through the bark and soft wood, and giving off *laterally* in its descent elaborated sap, finally changed into bark and wood. Thus the radiated tracheæ of the wood give off and disperse laterally the ascending juice of the lymphatic tubes, and those of the bark the descending or nutritive and

* Mr. Forster has also observed a lambent electric light about the leaves of plants.

elaborated juice to the bark ; the first adds a new layer of *alburnum*, or young wood, and the second a new layer of *liber*, or inner bark. M. Dutrochet found an interesting illustration of this in some of his experiments. He took the *cæcum*, or blind gut of a chicken, and, having nearly filled it with milk, it was immersed in water, which was found to be *absorbed laterally* ; after some time the milk underwent chemical decomposition, and the water that had been absorbed was *expelled* by the same orifices through which it had previously entered. Suppose a glass tube had been inserted into the *cæcum* ; it is evident that when the water was absorbed the liquid must have risen in the tube, as exemplified by Dr. Hales in his experiments on the bleeding vine, and still more interestingly so in one made by Mr. Braddick, who, having attached a bladder to the orifice of a bleeding vine, found that in twenty-four hours it expanded, and became as hard as a cricket ball, and in some hours after burst with explosive force. A curious fact was lately communicated to us, and which we consider in some measure corroborating Dutrochet's theory. A twig was picked up in a wood during a severe frost, with part of its bark detached : from this denuded surface an innumerable quantity of minute capillary filaments of ice protruded ; they were parallel to each other, and horizontal. It appeared, that the sudden expansion of the fluids included in the tubes already described had projected jets in a horizontal direction, through the lateral orifices, and which, being suddenly congealed, presented the curious phenomena already described. As a verification of Dutrochet's opinion, it should be remembered that electricity is always efficient in every chemical change ; therefore, when the milk passes into the acetous fermentation, its power is exemplified, and

must act very dissimilarly during that phenomenon to what it does before decomposition ensues. The ascent of liquids in virtue of capillary attraction is a problem the solution of which has perplexed the enquirer, and, in truth, we know not how it is to be explained apart from electrical attraction. The substitution of *recent blood* for milk in Dutrochet's experiment beautifully illustrates his position; because the finally expelled liquid will be tinged red by the coloured globules of the blood, and thus dye the liquid medium which surrounds the cellular tissue.

There are peculiar phenomena in vegetable physiology wherein an unusual quantity of limpid water is secreted by the plant, and which in all probability is connected with some organisation peculiarly acted on by electricity. Thus, what has been called the *wild pine*, an exotic found in South America and the West Indies, and parasitic on the trunk and branches of some trees, is composed of foliaceous bags, serving as reservoirs for water obtained from the atmosphere, in the form of dew or rain. These severally contain from a pint to a quart of water, and an appendage prevents its evaporation; it becomes an interesting resource against thirst, both to the inferior animals and man, and no doubt the former class are well acquainted with these providential supplies; at least it has been ascertained that animals of the *Simia*, or monkey kind, are no strangers to the fountains of supply contained in the pitchers of the *Nepenthes distillatoria*. In the case, however, of the *wild pine*, as well as the *Sarracenia adunca*, &c. in which last are also pouches for the reception and retention of water, they may be considered as vegetable tanks or cisterns: it is different in the *Tillandsia*, or "water with" of Jamaica; since here, as well as in the *Cissus latifolia* of the East

Indies, it is evidently a secretion of the plant : a piece of the former, two or three yards long, supplies a copious draught of water ; and when the latter is cut, it is found so full of sap that a continued stream flows out. The watery fluid found in those curious foliaceous adjuncts, the *pitchers* of the *Nepenthes distillatoria*, is evidently a vegetable secretion ; because we have seen it contained in the pitcher *before* the lid had opened, and shall elsewhere give our chemical examination of this liquid, as well as a description of the curious mechanism of the lid.* There is a phenomenon in vegetable physiology to which we have paid considerable attention, and last summer observed an extraordinary instance of the kind : it is described, because it seems to be associated with electricity. Doubtless many streams, rivulets, and rivers, owe their source and vigour to a similar cause, and have had their occult springs amid the deep recesses of the forest : the condensation of vapour, as in fogs by trees, that otherwise would exhale in the sunbeam, or dissolve in the aërial abyss, is a curious and interesting phenomenon. We find that by act of parliament it is expressly provided that no tree shall be suffered to remain, or be planted within fifteen feet of the public roads, and that commissioners of roads are authorised to cut down every such tree ; this however is, we are afraid, seldom attended to. In Kentucky many brooks are pointed out which now fail

* The *Nepenthes distillatoria* is a native of Ceylon, Amboyna, Madagascar, and other places, as well in Asia as in South America. Its leaves and stalks are very vascular ; and the inflated pitchers contain two or more ounces of liquid. The *Cala æthiopica*, and *Agapanthus umbellatus*, sometimes, after having been freely watered, distil from the tips of their leaves liquid matter.

in summer, — a circumstance unknown twenty or thirty years ago ; and in New Jersey, where the woods have been cut down, some streams are altogether dried up. The author of “ The Journal of a Naturalist ” remarks, in reference to the condensation of vapour by trees, “ That a young wych elm in full leaf affords a good example ; ” and mentions a well marked case of this kind : — “ The weather had previously been very fine and dry, and the road in a dusty state ; but a fog coming on, an ash tree hanging over the road was dripping with water so copiously that the road beneath was in a puddle, when the other parts continued dry.” * Mr. White, who seems to have allowed almost nothing to have escaped his intelligent watchfulness, says “ In heavy fogs, on elevated situations especially, trees are perfect alembics. In Newton Lane, in October, 1775, on a misty day, a particular oak in leaf dropped so fast that the cart-way stood in puddles, and the rims ran with water, though the ground in general was dusty.” Evergreens might thus be planted with advantage round ponds where a perennial supply is wanted ; and if we mistake not, we have seen demonstrable evidence of this description in the case of a circular pond, at Castle Kennedy, the seat of the Earl of Stair, whose venerable woods and sylvan beauties, we regret to learn, are doomed to be destroyed. Rain will always be more frequent and copious, and oftener repeat its periodic return, to the spot shaded by trees, than in open districts of the country, and apart from them ; a fact of the utmost importance in the *formation of roads*, and should never be lost sight of. The intelligent traveller, in looking around him, must feel persuaded of this palpable truth : many a rill, and even

* Journal of a Naturalist, Lond. 1829. p. 62.

river, has disappeared where woods have been levelled. The great features of a country have been thus changed; and we doubt not but rivers have rolled in ancient Caledonia before her forests were felled, and of the existence of which we have now no memorial, except in the organic remains occasionally exhumed from the deposit of the channel of a former river; thus our intelligent friend, Patrick Ncill, Esq. has clearly proved that the *beaver* was once indigenous to Scotland*: it is, however, America that presents less equivocally the picture consequent on dried-up rivers. The geologist should not omit this important truth in his speculations, for it will certainly solve satisfactorily some phenomena in alluvial deposits.

It must have been observed, that, under circumstances when the roads have been parched and dusty, the surface of the ground round particular trees has been so saturated with moisture as if it had rained copiously on these favoured spots, and nowhere else; and according to our numerous observations, the *elm* seems remarkably prominent here. Glas, in his account of the Canaries, informs us, that in one of these islands the entire supply of water proceeds from a vegetable source, and that it is measured out to the inhabitants under the jurisdiction of the municipal authorities; dense clouds proceeding from the ocean, are attracted by a tree, which grows on the declivity of a hill, and the vapour here condensed falls in the form of a shower into a tank beneath; it is therefore called the "raining tree." In the month of July last we witnessed a striking instance of this kind in the

* In the time of Giraldus Cambrensis, the only beavers remaining in Wales or England were in the river Towy: "Inter universos Cambriæ, seu etiam Loegriæ fluvios, solus hic (Teivi) castores habet." This was about the year 1170.

vicinity of Stafford, on the Lichfield road : clouds of dust rose on the main road, and a dense fog hovered over it ; but no moisture was precipitated except in the vicinity of the trees and hedges ; and here the deposition was considerable, but especially in the case of a lofty insulated Lombardy poplar, where the fall was so considerable that it might have been used as an admirable *shower bath*, and so complete a rivulet was formed as might have been directed with effect to turn the wheel of a saw-mill. Thus rivulets may be created by plantations, and have been formed by them : the pond embosomed in woods will rarely dry up, and its supplies be seldom exhausted ; while gentlemen may hereby obtain a useful hint in reference to ornamental landscape. By a considerable increase of our woods the climate may eventually be entirely changed ; and, on the other hand, by the introduction of trees arid wastes may be softened down into a genial soil, susceptible of cultivation : even parched islands, such as Antigua, &c., might be reclaimed from that drought to which their inhabitants are frequently doomed. It is in the *oases* of the desert that wells are found :—" They came to Elim, where were twelve wells of water, and threescore and ten palm trees ; and they encamped there by the waters." *

These remarks may be considered somewhat exotic, though all are, indirectly at least, allied to the subject, and it is presumed that their interest may be found sufficiently apologetic.

We have been informed that a gentleman, who has paid great attention to experiments on electricity, discovered, one evening, on his return home, the spiny summits of a thorn singularly studded with stars of

* Exodus, xv. 27.

electric light : and it may be added, that Dutrochet is of opinion negative electricity imparts the powers of *absorption*, and positive electricity those of *secretion*. M. Astier concludes that the leaves, thorns, and hairs of plants tend to maintain in them the requisite proportion of electricity ; and by drawing off from the atmosphere what is superabundant, act in some measure as lightning rods, or paragrêles. Astier insulated the thorns of growing plants ; and upon being exposed to the atmosphere when the electrical equilibrium was disturbed, they distinctly affected the electrometer.

The electric powers of certain kinds of fish have been long known, such as the *torpedo*, *silurius electricus*, *gymnotus electricus*, *trichiurus indicus*, and *tetraodon electricus*. While the *torpedo*, a flat fish of the ray kind, was well known to the ancients, it does not appear that the peculiar properties of the *gymnotus electricus* were recognised before the end of the seventeenth century ; and it was Mr. Walsh that first identified this singular phenomenon with electricity. Humboldt give us, in his “ Personal Narrative,” an amusing account of the method practised in South America for catching the electrical eels, by means of wild horses forced into the water, the electrical eels becoming finally exhausted by an expenditure of their energy : by these animals, as in common electricity, the shock is freely communicated through conductors, but not transmitted through electrics ; and when the shocks of the larger gymnoti are passed through an interrupted circuit, they even yield the electric spark : the electric organ consists of an extensive series of irregular columns divided by horizontal partitions which expose a considerable surface ; and the interstices seem to contain a fluid, which may give rise to the

electric influence. The torpedo is found in the Mediterranean and North Seas, rarely exceeding eighteen to twenty pounds weight; and the rapidity with which it communicates the shock is considerable, sometimes amounting to fifty in a minute and a half: it should seem that the shock is dependent on the will of the animal, and each shock accompanied by a depression of the eyes, while the intensity is stated to be four times stronger when the fish is insulated and surrounded by air. We were informed by Signor Mojon, professor of chemistry in the University of Genoa, when there, that it was endeavoured to ascertain by experiment, whether a series of torpedos, arranged in separate tubs, and conjoined with conductors, in the manner of the *Couronne des Tasses*, would decompose water, as in common electricity: the attempt, however, was unsuccessful; nor do we think that this might have been expected, because it would have required a series of *simultaneous* shocks, as well as a continuous succession of them to have produced the effect.* Heat seems to increase the electric property in these animals; and we were told that the *temperature* of the water in which one of these fish was placed having been accidentally raised too high, Mr. Walsh, by incautiously handling it at the moment, received so violent a shock as to lay him prostrate. On the authority of Spallanzani, the dying torpedo communicates its shocks more frequently than at other times, but they are then feebler; and the same naturalist assures us that the youngest torpedo can exercise the property in question. The *gymnotus electricus*,

* A posthumous paper of that much lamented and distinguished philosopher, in reference to this subject, has been lately read before the Royal Society.

or Surinam eel, abounds in the rivers of Surinam * and Senegal: it is generally about three feet long, but occasionally met with ten to twenty feet long, sufficient even to kill a human being: the nerves immediately connected with these organs are larger than in other parts of the system: these have a reference to temperature, and a comparative relation to the media of air and water, the latter being an inferior conductor, and the former, when quite dry, being an electric of a superior kind, and only changing its character by means of the watery vapour it contains. We are of opinion that the electric organ of the *torpedo*—perhaps we may extend it to other electrical animals—is more subservient to the process of *digestion* than to that of catching its prey; and this opinion is also maintained in a late volume of the Transactions of the Linnæan Society. The curious experiments of Dr. Wilson Phillip go to prove that the galvanic influence produces an analogous result to that of the nervous power, and seems, in his researches, to have been successfully substituted for it. From the preceding observations it is evident that the animal machine is intimately connected with electricity, and we may infer this applies not merely to those extraordinary fish now reviewed, but to *all* animals, though in the torpedo, &c. it be most conspicuous, and the energy more concentrated; it is sufficiently obvious, therefore, that atmospherical electricity must affect the animal system more or less, and modify its powers of action; and the same thing applies to the process of vegetation: it is well known that when we rub the back of a cat, electric sparks are

* A physician informed us he has frequently received a shock from the *gymnotus electricus*, in the rivers of Surinam, by touching the fish with a dirk: it extends considerably up the arm, inducing a benumbing torpor or paralysis.

copiously emitted, but it is not so generally known that if we do this and lay one hand on the throat of the animal, while we apply the other to the back, we shall receive a distinct electric shock : an experiment first pointed out by Glover. Mr. White describes a case of intense frost, and adds, “ During those two Siberian days, my parlour cat was so electric, that had a person stroked her, and been properly insulated, the shock might have been given to a whole circle of people.”

The insect world seems to be as powerfully affected by aërial electricity as any other. Huber, it would appear, has from repeated observation proved that electricity is immediately concerned in the secretion of honey ; that bees are especially active and laborious before the approaching storm, when the air is warm and humid and the wind is from the south. — “ Insects seem particularly excited by a high electric state of the atmosphere, and are then found more numerous on the wing than at ordinary periods and toward evening ; and sometime before the storm comes on, various kinds may be then seen that do not appear at ordinary times, but immediately before the storm all disappear.” * These facts and a variety of kindred phenomena must have been often observed even by individuals the most inattentive to the wonders that surround them. D’Isjonval believed spiders were peculiarly susceptible of aërial electricity, and that the extent of the threads they spun were prophetic of the kind of weather that was to follow : if these were long, fine weather would succeed ; and, on the contrary, if they were short, stormy weather and rain followed. An anonymous writer, under the signature of “ Carolan,” considered that the spider’s thread

* Kirby and Spence’s Introduction, &c. Lond. 1828. 4 vols. 5th edition, p. 204.

when propelled by the insect was invested with some subtile *aura* which might be of an electric kind.

The power possessed by some kinds of spiders of propelling their threads into the atmosphere, and of effecting an aërial ascent, are among the most recondite and curious problems in natural history, — facts, though long questioned, substantiated beyond a doubt. In a paper published in the Memoirs of the Wernerian Society of Edinburgh, we endeavoured to prove that it was an *electrical phenomenon*, and the facts to which we referred seemed, to us at least, to be conclusive. M. Gay Lussac having found that though a soap bubble ascends readily *sub die*, it does not ascend within doors, ingeniously, as an inductive consequence, ascribes the rise of the clouds in the air to the impulsion of the ascending currents resulting from the difference of temperature between the surface of the earth and the superior regions of the atmosphere : — this is precisely the principle which Mr. Blackwall of Crumpsall Hall has applied more recently to the ascent of the gossamer spider. Many phenomena seem to militate against this view of it : in the first place these ascending currents have a problematical existence : it is not denied that caloric radiates from the earth to the heavens, but this is chiefly nocturnal ; and it is presumed cannot be that referred to, because our aëronauts then descend ; and if we are not strangely mistaken, these apterous insects ascend most readily when the solar rays are most powerfully impinging on the terrestrial surface. Mr. Blackwall has described a most extraordinary circumstance, namely, the *ascent* of a tissue of spiders' threads and cobwebs of various lengths and breadths. As far as we know, nothing of the kind has ever been observed by the most acute and diligent naturalists ; and therefore the phenomenon,

as to any parallel record, is altogether unique ; and did it not appear uncourteous, we should rank it either *sui generis* or a *deceptio visus*. Showers of cobwebs, and the *descent* of spider's threads, we, in common with many others, have *frequently* witnessed. Mr. Blackwall has, however, from this assumed fact, concluded that the myriads of gossamer spiders which have descended at night are raised bodily upwards, *webs and all*, into the air by the impulse of these heated emanations, and when they cease alight on the earth. It may here be legitimately asked, how it happens that the aërial spider *ascends* after that period of the day when these ascending currents are supposed to cease, and that the spider will descend when they are presumed to be in active operation ? And further it may also be reasonably enquired, how is it that the spider *descends* in the face of such a buoyant efflux, and as immediately, having projected its thread, ascends again ? These are difficulties to which, on this hypothesis, it will be found no easy matter to return a satisfactory answer. Moreover, in the heat of the day, our hedges are occasionally full of floating threads, often stretched across the road, or extending from tree to tree, or waving in the wind ; and when these heated currents should be at work, our meadows will be one tissue of gossamer obstinately attached to the ground ! So much then for the question of ascent. It has been also contended that spiders possess no power to propel their threads unless aided by a current of air.

This last, resolving itself into a totally different phenomenon, must be considered apart from the others. In order to put this to the test of experiment, Mr. Blackwall insulated some spiders on a twig by surrounding it with water, and covered them with a bell-glass ; and since it appears that the imprisoned insects

never attempted to make their escape, it is concluded that they were utterly unable to propel a thread to the extent of even the fraction of an inch. To this and to every thing else that Mr. Blackwall has advanced on the subject, Mr. Rennie in "Insect Architecture," says "Amen." Now, without assigning to these spiders the intelligence and sagacity of Mahomet's spider, it seems very natural to suppose they were sensible that their range was bounded by the crystal hemisphere which covered them. Be this as it may, we had, in the communication alluded to, mentioned the fact of the propulsion of a thread in the very "teeth" of an aërial current; but the spider can also dart a thread *instantly* the next moment to the ceiling, and at right angles with the other: and not limited to a longitude of *inches*, the gossamer spider occasionally propels, with the rapidity of a ray of light, a thread from 20 to 30 feet long! That a current of air may enhance this power of propulsion in the insect is very likely to be the case, and that it has also the property of darting this counter to the current is an undisputed fact. It remains only to be determined whether this can be effected in tranquil air under any circumstance. In the bright sunbeam we feel persuaded the gossamer spider can propel its threads, be the air ever so calm and motionless. The philosopher of Selborne, to whose authority we are always happy to make an appeal, observes, in reference to the gossamer spider, "Last summer one alighted on my book as I was reading in the parlour; and running to the top of the page and shooting out a web, took its departure from thence. But what I most wondered at was that it went off with considerable velocity in a place where *no air was stirring*, and I am sure I did not assist it with my breath." Mr. Blackwall consi-

ders, moreover, that the threads “are drawn out by the ascending current of rarefied air,” though it is difficult to conceive what connection this can have with “air blown upon them,” and when the *ascent* is stated to have taken place on the 1st of October, 1826, there was “no wind stirring.” “By blowing gently toward its position,” (the spider?) Mr. Rennie “had also the pleasure of seeing the double or bend of the thread that was blown into the air;” and he has also observed that the spider “can produce a line, not only when the current of air is strong,” but also “when there was scarcely a breath of air.”

In reference to currents of air it may be here stated, that Mr. Black ascertained in the Mediterranean by many experiments, that winds or currents of vapour of some continuance from the sea are invested with *negative electricity*, and those from the land *positively electrical*; and in the case of opposing currents in different electrical states, a transference of electricity follows.—In the autumn of 1818, Signor Morrichini of Rome informed us, during our visit there, that he had found the solar spectrum invested with electric properties. Savario Barlocci, and Carlo Matrucci of Forli, have since also proved the communication of electricity by the solar ray. The latter observed that the glass plate which became electric by the sunbeam never evinced this property when the disc of the sun was obscured by a cloud. Excited by the action of the solar ray, or a current of air, which by the experiments of Bennet, and other electricians, is sufficiently proved to be an excitant of, or to induce, electricity, the gossamer spider propels its threads into the air; and when sufficiently buoyant, ascends in its silken balloon and parachute constructed of them: the threads, imbued with electricity

by their impulse through the air, are preserved electric by the continued action of the electricity of the solar ray. We have found that an electrified soap-bubble ascends within doors, and Mr. Bowman, F.L.S., has described a phenomenon which is perfectly inexplicable, except on the supposition that the threads are invested with electricity:—it is the ascent of the spider by two distinct *divellent* fasciculi of thread separated by a considerable angle. On the 28th of July, 1829, we made numerous experiments with the aëronautic spider, in a hay-field near Hull; and found in one case that three of these insects, being suffered to ascend from the same spot, moved each in a contrary direction.—In No. XII. of the Magazine of Natural History, p. 147., Mr. Thompson describes a singular flight of spiders observed by him in St. John's church, Hull, on the 19th of that month:—"The tops of ladies' bonnets were generally the places whence they commenced their flight, and in it they seemed not to be confined to any particular direction: some flew upwards at a slight angle, some north, some south, some east, some west; and in so doing several passed so near to each other that I cannot conceive, as they passed in opposite directions, that any current of air conveyed them, as two opposite currents could scarce exist so often close to each other." It would, however, be injudicious to pursue these curious investigations in this place; since the subject is discussed more amply elsewhere*; and it is presumed that the proofs drawn from the multitude of experiments and observations there referred to, amount nearly to demonstration. The descent of the gossamer, which there is every reason to suppose is produced by the insect in the atmo-

* "Researches in Natural History," Second Edition.

sphere, and not carried up from the surface of the ground, seeing it is not denied that the spider can, when suspended in the air, shoot out its threads, will always be the precursor of rain or storms : every additional thread propelled, in all probability, carries the spider to a higher elevation.

CHAP. VII.

UNEQUAL DISTRIBUTION OF TEMPERATURE. — THE
 METEOROLOGICAL FEATURES OF THE CLOUDS DE-
 PENDENT ON THEIR ELECTRIC CHARACTER. — DEW.
 — RAIN. — HAIL.

DESSAIGNES has shown that heat modifies the kind and quantity of electricity ; that, in fact, electricity is excited whenever any body is unequally heated : and it may therefore be considered an unequal distribution of heat and moisture in the atmosphere will determine the evolution of the thunder storm. We were much surprised at the very rapid change of temperature which took place during a thunder storm near the Rhine, observed in 1825 ; the extreme limits of this vibration of temperature amounted to nearly 14° F. and the oscillations were exceedingly abrupt : the curious configurations of the clouds, and all their numerous ramifications and modifications owe their being and change to electric power and influence. Mr. Howse, a very extensive traveller in the regions of North America and among the Esquimaux tribes, mentioned to us a very extraordinary phenomenon witnessed by him, in the atmosphere about latitude 57° : the entire atmosphere seemed like *eddies* and *circles* in constant motion, widening and falling into each other, and beautifully coloured *green* and *red*, &c. : this continued for many hours, and was observed by another individual at the same time, though nearly 150 miles distant. Clouds are understood to be visible aggregations of minute aqueous particles held in sus-

pension in the atmosphere ; and such may cease to be visible from their extreme attenuation or diffusion, or melt away in the atmosphere, being dissolved ; or their destruction may be effected by resolution into rain. We are indebted to Mr. Howard for an arrangement and classification of the clouds : they are comprehended under the general terms, *cirrus*, *cumulus*, and *stratus* ; these occasionally combine or mix together, and produce intermediates, as *cirro-cumulus* and *cirro-stratus* ; there is also the *cumulo-stratus*, and a combination of the entire three, the *cirro-cumulo-stratus*, *nimbus*, or rain cloud. Generally speaking, the three simple forms of cloud are suspended at different degrees of elevation in the order in which they are placed, the *cirrus* being highest, and the *stratus* lowest ; the latter appears generally reposing on the verge of the horizon : the *cirrus* has been called the *Proteus* of the skies, from its frequent and rapid changes ; it is the first cloud seen in clear weather : sometimes pencilled and thready, or fibrous, oft-times the end resembles a brush ; this form of the cloud may be considered as at antipodes with the *nimbus*, or storm cloud, and dry weather, easterly winds, and luminous meteors, or shooting stars, are its usual attendants : the *cumulus* is exhibited, as it were, in flocculi or fleeces, or patches, acting occasionally as skreens to intercept the sunbeams : before rain they increase rapidly, and descend to a lower plane in the atmosphere : in some cases they present hemispherical masses, like alpine ranges with fleecy summits ; are occasionally seen to evaporate as soon as formed, or an aggregation is formed by numbers of these coalescing : these modifications and inosculation are doubtless the effects of an electric change : when the *cirrus* and *cumulus* together form the *cirro cumulus*, they

quarter of an hour, half an hour, or more, and at others is suddenly extinguished, and does not appear for some time." * "These luminous medusæ are called at Messina, *bromi*; and in the Lipari Islands, *candelieri di mare*." A third kind of phosphorescency is *peculiar* to gulfs, bays, and shores, and is very easily excited, by any thing in fact which stirs the water, since the mere movement of a fish is sufficient to excite a gleam. In this case it resembles a sea of milk, of a pale diffused light, as when phosphorized alcohol is poured on the surface of cold water. The first and last of these phenomena appear ascribable to the presence of minute *crustacæ* or *molluscæ*. The intermediate variety seems to be the effect of larger medusæ, and of these only two have been discovered, the *medusa pellucens* and *m. spallanzani*. The last description of luminosity is comparatively rare, and the appearance, described by Mr. Thompson, witnessed in the bay of Gibraltar, was, as if "passing through a sea of melted silver;" this phenomenon was occasioned by numerous luminous points, less than the smallest pin's head, of the softest and most destructible tenderness: closely inspected, they appeared like hemispherical masses of a colourless jelly, and are supposed, with much probability, to have been some species of small medusæ.

The *cancer fulgens*† of Sir Joseph Banks (*noctiluca Banksii* of Mr. Thompson), or luminous shrimp, is found towards Rio Janeiro, (between lat. 5° 25' S., and 29° 30' N., and West long. 17° 18', and 32° 55'), they were found abundant; and it is evident their geographical range is considerable. "The motions of the animal were lively, and it gave out brilliant scintillations

* Travels, vol. iv. p. 229.

† See Plate, fig. 5.

in the dark. It was perfectly transparent; tinged here and there with orange red, particularly its anterior feet, and showed the circulation most distinctly."

Lucifer is a molluscous animal, which contributes in tropical regions to the phosphorescence of the sea. It is colourless and transparent, with the exception of the intestinal canal. It is altogether a very odd-looking creature, somewhat vermiform; its eyes are extremely large, and protuberant, terminating in diffuse foot-stalks. It was taken by Mr. Thompson in the Atlantic, N. lat. $11^{\circ} 56'$, W. long. $32^{\circ} 55'$. The *podopsis*, or hammer-headed shrimp, has a distant resemblance to the preceding, and was also caught in the Atlantic, N. lat. $29^{\circ} 30'$, W. long. $32^{\circ} 55'$.

Besides a general luminosity in the ocean, it would seem that there are instances of a more local or specific kind. Mr. Thompson informs us that one is presented to the mariner under the semblance of thick bars of metal about a foot long, as it were ignited to whiteness, and scattered over the surface of the ocean: this apparent incandescence is seen close to the vessel, and to follow after, and is owing to the *pyrosoma atlantica*, a compound animal, resembling a hollow cylinder, of a transparent gelatinous substance open at one end, and protuberant on its surface: this was first discovered and figured by Peron and Le Sueur: the light appears to pervade the entire substance of the animal, and is of a bluish or greenish tinge like a pale sapphire or aqua-marine. This phenomenon may be often witnessed by vessels bound to India, or the eastward of the Cape of Good Hope, in calm latitudes near the line. Its geographical distribution had been limited to 19° and 20° longitude W. of Paris, and 3° and 4° of N. lat. Mr. Thompson, however, met with it

in latitude 12° N., and extending from W. long. 16° to 20° . Toward the equator, a smaller species made its appearance intermixed with the other, the light “seemingly arranged in rings or whirls resembling a gem studded with the diamond or opal.” It did not exceed an inch in length, and had seven or eight rows of dots, and a somewhat contracted aperture. These were in all probability either its ova or its young. This last is the *pyrosoma pygmæa* * of Mr. Thompson.

Another kind of luminous appearance was observed by Captain Horsburgh in the Arabian Sea. It somewhat resembled the *oniscus*, and was about one third of an inch long. “During the time,” he says, “that any fluid remained in the animal, it shone brilliantly, like the fire-fly.” It was also found by Mr. Thompson off the southern extremity of Madagascar, and again on the Agullas banks near the Cape of Good Hope. It is the *sappharina indicator* of Mr. T. † This creature is described as beautifully luminous by night, and by day resembling the finest blue sapphire in colour, with the opalescence of the adularia or precious opal. By direct transmitted light, it resembled the fire stone with tints of yellow, and by a less vivid and more indirect light, assumed various intermingled tints of orange, rose, blue, and green, possessed of a somewhat metallic splendour. Its geographical locality appears to be limited to the seas situated to the N. and W. of a line drawn from the Cape of Good Hope to the southern extremity of Ceylon.

Another phenomenon observed in violent storms at sea makes its appearance in a luminous patch or ring upon the masts and windward yard-arms, gradually

* See Plate, fig. 7.

† See Plate, fig. 6.

mounting up the former as the storm increases in violence. This phenomenon, we think, has been very properly ascribed by Mr. Thompson to luminous marine animals carried thither by the spray. This has doubtless been, and may indeed be confounded with an electrical phenomenon of a somewhat similar kind, called St. Elmo's Light, &c. by sailors ; — this last, however, is usually exhibited as a radiant star or phosphoric flame playing about the very summits of the masts.* The former, however, is attached to the *lower masts* and *windward rigging*.

In nocturnal insects the light has by some been supposed sexual : — this view of the matter cannot be supposed applicable to marine molluscæ, since the greater part have the sexes united, are destitute of visual organs, and some are even acephalous, and shine equally in their larva state or more perfect animal form. We certainly think Mr. Thompson's opinion good and happy. It is intended by Providence to illuminate the ocean scene in the dark and stormy night, when neither moon nor stars appear, and no small tempest lies upon the mariner ; and when the darkness " might be felt," the light will be most brilliant. " Coming events cast their shadows before : " — these become the presage of the storm, and reflect such a gleam on the ship and rigging as to enable the sailor to reef or furl his sails, and complete his task. At all times this curious living illumination " points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts, by the phosphorescent or snowy appearance which it gives to the breakers, so as to render them visible at a consi-

* " Treatise on Atmospherical Electricity." Whittaker, London, 1830.

derable distance ; — when again the diffused luminous appearance of the *sappharina indicator* is seen, he may be certain he is in soundings, and probably at no great distance from some fatal spot.” *

In terrestrial insects, peculiar organs seem to secrete or treasure up the luminous matter, and transparent spots permit it to be seen ; but in marine insects it generally seems to pervade the entire structure. Spallanzani by removing the luminous matter from medusæ, found that its phosphorescency was communicated to water and milk. He considered it a viscid secretion ; but in our opinion it is owing either to the eggs of the animals being luminous, or to parasitic animalculæ, which may be its food. Various have been the conjectures entertained on the luminosity of the ocean ; such as absorbed solar light, which the friction of the waves has evolved ; electricity, too, has been supposed an agent in the production of this wonderful phenomenon ; also diffused phosphoric matter ; while luminous animals have by other observers been considered the cause of the phosphorescence of the sea, and this last most rational opinion seems now fully substantiated.

An anonymous writer in Mr. Loudon’s Magazine of Natural History †, says that the idea of the phosphorescence of the sea being the presage of a storm has been long entertained among sailors, and in this case they should be the best judges whether the event proves it so : he continues to observe, that it may be seen all the year round in the Caribbean Seas, where there are no storms but in the hurricane months. This may be the case *there*, but may not be so elsewhere : we did not talk of the absence altogether, but

* Page 50.

† Vol. i. p. 304.

of an increase of brilliancy prior to the coming storm ; and if the sea were always phosphorescent in the same degree, sailors could have no basis on which to form the opinion attributed to them. Besides all this, the *peculiarity* of the luminous phenomena must be attended to ; for this character will sometimes indicate the introduction of exotic novelty, and the change of light may reveal it : — thus the luminous phenomenon of the *medusæ* is very differently characterised from that of the *cancer fulgens*, and that of the *sappharina indicator* from both. The *cancer fulgens*, though possessed of an extensive geographical range, is yet a stranger to our coasts, though it may be driven from its bearings by agitations in the ocean, and on our coasts become the forerunner of storms. It may be the case with others also : any increase in or modification of the common phosphorescency of the sea in specific latitudes may well therefore be conceived to be the presage of the coming tempest.

Thus may the instinct presentiment of beings, which from their minuteness we despise, warn us of our danger, and lift up, when commissioned by a beneficent Providence, the veil of futurity from events that are to come.

“ *Natura nunquam major quam in minimis.*”

CHAP. VII.

TORPIDITY. — GENERAL REMARKS. — TORPIDITY OF INSECTS. — THE ANT. — SIREN LACERTINA. — MARMOT. — DISTINCTIVE FEATURES OF TORPIDITY, AND REMARKS IN ILLUSTRATION. — INDUCTIVE CONCLUSIONS.

THERE are few topics less understood than the torpidity and migration of animals, though the most curious features in their physiology. The strangely protracted sleep in the former case is a phenomenon remarkable in itself, but remains as yet a problem :

“ Sic sine vitâ,
Vivere quàm suave est, sic sine morte mori.”

As the following observations on the peculiar habits of the tortoise, and experiments made on the temperature of the dormouse, animals that become torpid, may eventually aid the question, so some previous remarks on the phenomena of torpidity may not be out of place. In the insect world we are presented with numerous instances of torpidity, which ought, however, to be carefully discriminated from *hybernation*. Toward the close of autumn, and when winter is pressing on its confines, insects are busied in looking out for safe retreats, wherein they may securely pass the brumal period of the year. Some of these, thus sheltered from the storm and surrounded by non-conducting media, enjoy a temperature unhinged by meteor-

ological contingency. Others, however, become torpid, lose all sense and motion, and repose in this death-like state during the months of winter. Some insects pass the winter in their perfect state, such as the coccinellidæ and curculionidæ, others are changed. Several of the coccinellæ are solitary during summer, but in winter are found aggregated: though some of them are discovered out of winter quarters, even after the severe weather has set in.

The following remarks on the phenomenon of insect torpidity are by a most diligent and careful observer.* “The first cold weather, after insects have entered their winter quarters, produces effects upon them similar to those which occur in the dormouse, hedgehog, and others of the larger animals subject to torpor. At first a partial benumbment takes place; but the insect, if touched, is still capable of moving its organs. But as the cold increases, all the animal functions cease. The insect breathes no longer, and has no need of a supply of air; its nutritive secretions cease, and no more is required; the muscles lose their irritability; and it has all the external symptoms of death. In this state it continues during the existence of great cold, but the degree of its torpidity varies with the temperature of the atmosphere. The recurrence of a mild day, such as we sometimes have in winter, infuses a partial animation into the stiffened animal: if disturbed, its limbs and antennæ resume their power of extension; and even the faculty of spirting out their defensive fluid is re-acquired by many beetles. But, however mild the atmosphere in winter, the great bulk of hybernating insects, as if

* Mr. Spence. See “An Introduction to Entomology,” &c. 8vo. London. 1817. Page 442. vol. ii.

conscious of the deceptive nature of their pleasurable feelings, and that no food could then be procured, never quit their quarters, but quietly wait for a renewal of their insensibility by a fresh accession of cold." This description seems exceedingly accurate and just.

It has been supposed that bees become *torpid* in winter: this, however, is certainly a mistake; and the very phenomenon of their living in such perfectly constituted societies goes far to render the opinion questionable. Their very treasury of honey is a proof of the same kind: why this store but for the winter of the year, when not a flower unfolds and not a sweet is disclosed? "She therefore provideth her meat in the summer, and gathereth her food in the harvest." We know but too well, that if the hive be not defended against cold, or be stocked insufficiently to support a genial temperature, it will inevitably perish, though we have certainly restored to the hive bees that have been accidentally frozen. According to Huber, the warmth of a well-tenanted hive in winter is 86° Fahrenheit, and our own observations confirm his statement. John Hunter found that a hive lost, from 10th of November to 9th of February, more than 4 lbs. in weight. Ants become torpid, according to the same author, at 27° Fahrenheit, but, by huddling together, endeavour to preserve themselves from the severity of cold.

Respecting the torpidity of ants, we begged the favour of Mr. Denny of Leeds (whose *formicaries* we have witnessed with pleasure) to ascertain this question for us last winter, and the following is an extract from his letter dated 29th of December: — "The weather seemed favourable for ascertaining the question of the torpidity of ants, as the thermometer stood at

30°, and we have had some tolerable falls of snow, with continued frost, for some days. My first excursion was to Killingbeck, about three miles from Leeds, where we discovered a *very extensive* colony of yellow ants (*Formica flava*) in a hilly part of the lawn surrounding the house of Thomas Walker, Esq., which appeared to penetrate full two feet below the surface. Upon breaking up the ground with a spade, the earth came up in solid masses and partially frozen, each of which presented numerous apartments and galleries, in many places quite blocked up with *ants*, very close together, probably to collect a little warmth. When first exposed to the air, they moved their antennæ slightly, and walked in a very feeble manner, endeavouring to get under shelter : many which fell upon the snow became very quickly motionless and perished : amongst them were several larvæ, in different stages of growth, from half a line to two lines in length. Although I did not dig to the bottom of the nest, I brought home, I should think, at least 1500 or 2000, numbers of which have since died from some cause or other ; perhaps the sudden change of temperature. My second excursion was to Kirkstall woods, when the thermometer was scarcely 30° F. I dug at my old hill of *Formica rufa* (the hill or horse ant), but could not find a single specimen, so that they must be at a very considerable depth : however, I was fortunate enough to find a nest of the turf ant (*Formica cæspitum*), which was beneath a patch of weeds, with a slight layer of earth, upon one of the many large blocks of stone lying about the woods. The outside of this habitation was cased with ice ; and, when the thin covering they had, and the cold stone for a foundation, is considered, these must have been at a much lower temperature than the yellow ants. The colony

was not so numerous as the former, but nevertheless a tolerably good one, and containing, even at this time of the year, *three fine* queens. These, however, were not in a more torpid state than the yellow ants, but moved about very leisurely. The difference in size of the workers (?) here is very remarkable, some being more than twice the size of others, the least of which (if they are the same species, for I have not yet minutely examined them,) appear objects of great care and anxiety to the larger; who, as soon as they were sufficiently recovered from the cold, eagerly sought after them, and carried them in their mouth to a place of security: the lesser seemed particularly to comprehend their meaning, for they immediately rolled themselves up, and allowed themselves to be carried without the least resistance. Huber says, ants do not become torpid till the thermometer sinks to 2° Réaumur (27° F.): in this case, my examinations have been too early. I shall, however, again renew my search. In my yellow ant, before mentioned, I noticed a curious proof of their tenacity of life. Two or three which I mutilated in digging, or some way or other, so as to remove the entire abdomen, were walking about very composedly after *three days*, and even offered resistance; which shows the vital power must be very great, as the animal is but one line and a half, or two lines at most, in length."

The eggs of insects are remarkably defended against cold. Spallanzani exposed the ova of the silk-worm, with those of other insects, to the action of a freezing mixture, 38° below zero, Fahrenheit, but they were neither frozen nor had their fertility impaired. Insects may be frozen into solid masses of ice, and yet revive: in Capt. Franklin's Narrative, we see this extraordinary fact in the instance of an icy mass of

mosquitoes. Lister states that he has found caterpillars so frozen, that, when dropped into a glass, they clinked like stones, and yet revived. Mr. William Stickney, of Holderness, exposed some of the larvæ of the *tipula oleracea* to a severe frost, which congealed them into ice: when fractured, their whole interior was found to be frozen — yet several of these were re-animated. Bonnet exposed the pupæ of *papilio brassicæ* to a cold amounting to zero of Fahrenheit: they became masses of ice, yet produced butterflies. Spallanzani made the curious observation, that insects re-appear in spring at a temperature considerably lower than that at which they retired in autumn. Agreeable to what has been mentioned, it is to be regretted that authors have not discriminated “between the *state* in which animals pass the winter, and their *selection* of a *situation* in which they may become subject to that state.”

There can be no doubt that a continued artificial warmth would prevent many animals from entering into a state of torpidity; and the insect so destructive to the favourite of our flowers, the *aphis rosæ*, if exposed in winter to the inclemency of the season, becomes torpid, while in the greenhouse it preserves an active and animated being. It cannot be owing to any effect of cold *previously felt*, that they are induced to make preparation for their long repose: it must be by a *law* of their being, imposed by Providence, “that, *previously* to becoming torpid, they select or fabricate commodious retreats, precisely adapted to the constitution and wants of different species, in which they quietly wait the accession of torpidity, and pass the winter.” It has been very properly remarked, that the fact of insects hibernating at the close of autumn, and their *not* doing

so in summer, when intense cold and frosty nights occasionally prevail, is a sufficient refutation that *cold* alone cannot be the exclusive agent. “We may say, and truly, that the sensation of fatigue causes man to lie down and sleep; but we should laugh at any one who contended that this sensation forced him first to make a four-post bedstead to repose upon.”*

“A continuance of life,” says Dr. Reeve, “under the appearance of death, a loss of sensibility and of voluntary motion, or suspension of those functions most essential to the preservation of the animal economy — these are the phenomena which accompany the torpid state, and they constitute one of the most singular problems in the whole range of natural philosophy.”† When we contemplate animals shut up in their subterrene abodes during the brumal period of the year, we shall find that, in those which become torpid, the temperature of the skin is reduced to a low ebb, the circulation of the blood is entirely suspended, and respiration at an end; the torpid animal has contracted its limbs into the form of a ball, and is generally rolled up in some substance dry and non-conducting as to temperature: such nests are formed of dried leaves, grass, and the like. The dormouse we always found rolled up during the season of repose, and it had carefully wrapped the dry moss round itself. Perhaps one of the most extraordinary phenomena of this description is exhibited in the case of the *dipus canadensis*, or the Canada jumping mouse, which has been found twenty inches beneath the surface of the ground, completely enveloped in a

* *Ubi supra.*

† “An Essay on the Torpidity of Animals.” 8vo. London 1809. p. 6.

ball of clay nearly an inch thick. Now this material could not permit the functions of respiration to go on: though a loose and spongy texture, as of a sandy soil, might be supposed to minister, though slowly, to this process. When Mr. Neill's *siren lacertina* was presented to him by Dr. Munro, in 1825, it was *enveloped in a ball of mud or clay*, and received from the marshes of South Carolina. It was transferred from the greenhouse in April, 1827, to the stove, where it lives in a box of water, containing also moss. Here we have frequently seen this curious animal, which is capable of breathing at pleasure, either by internal lungs, or external branchiæ (gills): it will live several hours, either in or out of the water, and is therefore truly amphibious. It croaks like a frog, and is fed on worms; but seems desirous of concealment, and we have always had to remove the moss to discover it: it is capable of enduring a long abstinence; when we last saw it, it seemed very lively. Of the same description precisely is the repose of the toad and lizard, in the solid rock, several hundred feet below the surface of the ground. In such cases, it seems clear, respiration must have long ceased: for no sooner is their prison-house unsealed, than that which was first discovered an apparently lifeless and motionless form, begins to move, and at length exerts its functions, which seemed as hermetically sealed as its lapideous dwelling-place. It is quite clear, also, that torpidity is preserved inviolate in this enclosure, by the uniformity of the temperature in which it is found — from a two-fold cause, the nature of the lapideous mass, and the depth below the surface where it reposes. Increase of temperature, and contact with an atmosphere acting with all its electric, hygrometric, and barometric vicissitudes, seem

essentials to revival from torpidity. The toad and the lizard found sealed up in rocks, and the repose of seeds under ground for a long extended period, are merely an extension of the same principle, displayed at regular intervals every year, in the sleep of the tortoise, hedgehog, dormouse, marmot, and others, or in the insect and reptile world; or the repose of vegetation in the bud. The *erinaceus europæus*, or hedgehog, wraps itself up most curiously in a ball of hay, with which it may be supplied; the intertexture of the fibres is remarkably close, and the exterior surface quite smooth. We once had a tame hedgehog, and its habits a good deal resembled those of our dormice: it took its food always by night.

Dr. Reeve, in his "Essay on the Torpidity of Animals," has classed the phenomena of torpidity under the following heads:—

I. The temperature of hybernating animals is diminished.

II. The circulation of the blood becomes slower.

III. The respiration is less frequent, and sometimes entirely suspended.

IV. The action of the stomach and digestive organs is suspended.

V. The irritability and sensibility of the muscular and nervous powers are diminished and suspended.

On each of these a few remarks will be made, to preserve a somewhat arranged form: the causes of torpidity may also be glanced at, and general deductions made.

I. Mr. Hunter ascertained that the temperature of a hedgehog, at the diaphragm, in summer, was 97° Fahrenheit, when the thermometer in the shade was 78° ; when the air was 44° , the animal became torpid,

and its temperature $48^{\circ}.5$ F.; and the air being 26° , the temperature of the animal was 30° F. Pallas, in the case of a torpid hedgehog, found the skin under the belly $39^{\circ}.5$, and Spallanzani limits the decrease of temperature during torpidity to 36° F. The temperature of our dormice was 102° to 104° F.; Dr. Reeve found it 101° . The animal in a semi-torpid state, in our experiments, was at one time $62^{\circ}.5$, and at another 69° F. Dr. Reeve found the skin of the dormouse, when rolled up and torpid in winter, 43° , 39° , and even 35° , on the exterior surface, but in the stomach 67° and 73° —an approximation to our results: marmots have a temperature amounting to 101° and 102° , and this sinks in the torpid state even as low as 43° . The *arctomys marmota*, the marmot of the Alps, is that best known. Three new species, however, from the arctic regions, are described in the Linnean Transactions.* The *arctomys hoodii*, is a beautiful little animal, and received its specific name after that of Lieut. Hood, one of the party under the command of Capt. Franklin, in the overland expedition. The marmots of North America feed on vegetables, fruits, and roots; live under ground, and in the cavities of trees; and, like the alpine marmot, are said to be torpid during winter. For a description of the alpine marmot, we must refer to our little work on Switzerland†, p. 25, &c. It would appear that, though the exterior surface of the animal be of a similar temperature with the ambient medium, the internal temperature is higher. Spallanzani found the wood-mouse (which in Italy becomes torpid in November) in a torpid state, when the air in its cage was 43° , and the

* Vol. xiii. Lond. 1822. 4to. p. 579, &c.

† “A Glance at some of the Beauties and Sublimities of Switzerland.” London. 1829.

temperature of the skin 45° . It seems, therefore, clearly demonstrated, that in torpidity the temperature of the body is reduced.

II. In the case of the *mus cricetus*, when active and irritated, its heart beats 150 strokes in a minute; while in a torpid state the number of pulsations are reduced to 15. In the *bat*, the number of beats may be stated at 100, but when torpid these amount to only about 14. Dormice have a very rapid pulse; but when semi-torpid, the number of beats may be considered about 31. The action of the heart ultimately becomes imperceptible, and before this period the pulsations do not exceed 16. It is not probable, that though the circulation be reduced to its lowest pulse, and the diastole and systole become inappreciable, that the blood ever congeals, though it may become more dense. Spallanzani informs us, that if the abstracted blood of the marmot be subjected to a temperature even higher than that of the lungs of the animal, it is frozen, but is never found congealed in their torpid state, even after exposure to a cold several degrees below the zero of Fahrenheit: so true is it, that "in the blood is the life thereof." These facts show plainly, that though the circulation be in a state of torpidity, and reduced to its minimum, that agency, *superadded* to their material organisation, which we call *the principle of life*, preserves the circulating fluid in a liquid form.

III. By the experiments of Spallanzani, torpid bats lived seven minutes in the exhausted receiver of an air-pump, in which another bat perished in less than one half this period. Some animals will support such an attenuated medium for a long period: we found this in experiments with the *grasshopper*: the respiration seemed hurried and laborious, but it was not in-

jured after a long period of imprisonment. Spallanzani confined torpid marmots for four hours, in media of carbonic acid gas and hydrogen, without injury, while they perished when awakened in the gases. The same philosopher found no eudiometric change on several cubic inches of atmospheric air, after torpid bats and marmots had remained in it three hours. In 1795, Spallanzani found that torpid dormice, after being exposed to a temperature below freezing, remained uninjured in media of carbonic acid gas and azote over mercury; the internal surface of the glass was not dimmed by any moisture, consequently breathing must have been suspended. Sir J. E. Smith, President of the Linnean Society, has found that the respiration of a tortoise in winter was always slower than in summer. It may therefore be fairly concluded, that, in torpidity, respiration ceases.

IV. Mr. Hunter introduced food into the stomachs of lizards before torpidity was determined, and, on being subsequently examined during this period, it was found unaltered. In the case of the dormouse, marmot, and others, no food is taken immediately before torpidity commences, and at the close of torpidity, in spring, the stomach and intestinal canal are found empty. We find a similar fact in respect to the tortoise, which does not take any sustenance for some time before it becomes torpid, and rejects food also for a short period after it recovers from its lethargic state. Martial says, of the dormouse, —

“ *Tota mihi dormitur hyems, et pinguior illo
Tempore sum, quo me nil nisi somnus alit.* ”

Now, though the dormouse does not become fatter during torpidity, it may be considered as in good con-

dition, though, at its close, it has lost somewhat of its obesity. It is certain that the alpine hunters of Switzerland find the marmots fat in their holes ; and it is also known that, some time after they leave them, they are often seen emaciated. Spallanzani is of opinion that dormice lose weight by torpidity, and Mr. Cornish estimates this at from five to seven grains during the torpidity of a fortnight. We may therefore infer safely, that digestion has ceased entirely, but that there still may be a slow expenditure or waste, perhaps cuticular, in the shape of insensible perspiration.

V. Animals in a torpid state seem insensible to external agencies : the dormouse may be tossed up as a ball, or thrown to a distance, without any change of state. Volta and Spallanzani could not rouse the marmot from its torpidity by the electric spark, and it was only temporarily disturbed by the shock from a Leyden jar. Wounds have been inflicted, and their limbs broken, yet torpidity remained unhinged, as in bats and other animals. External stimuli, therefore, do not affect the torpidity of animals : heat and air, conjoined no doubt with electricity, are the only agencies which rouse them from this death-like lethargy.

“ The tribe of quadrupeds,” says Dr. Reeve, “ have the habit of rolling themselves into the form of a ball during ordinary sleep ; and they invariably assume the same attitude when in the torpid state, so as to expose the least possible surface to the action of cold : the limbs are all folded into the hollow made by the bending of the body : the clavicles and the sternum are pressed against the fore part of the neck, so as to interrupt the flow of blood which supplies the head, and to compress the trachea ; the abdominal viscera

and the hinder limbs are pushed against the diaphragm, so as to interrupt its motions, and to impede the flow of blood through the large vessels which penetrate it, and the longitudinal extension of the cavity of the thorax is entirely obstructed." Such is the phenomenon of the animal cradled in torpidity. Contrary to the opinion sustained by Mr. Gough and others, animals *prepare* for the singular state from instinctive feeling or presentiment, just as the silk-worm prepares its cocoon, where, wrapped up like a mummy in its sycamore coffin, it awaits its remarkable transformation.

We rest secure in this opinion, and acknowledge it as additional evidence of that provident care which excites our wonder and delight. A peculiar organisation is no doubt superadded by creative wisdom for this purpose; and Sir Anthony Carlisle informs us, that animals of the class *mammalia*, which become torpid in winter, have at all times a power of subsisting under a confined respiration, which would destroy other animals not possessed of this singular habit: he also discovered in them a peculiar structure of the heart and its principal veins. We may safely, therefore, draw from these premises the following conclusions, and they certainly seem inductive and warranted inferences:—

I. Some animals as *naturally* pass, by instinctive feeling, into the state of torpidity, as the swallow and other birds migrate, till Providence in due time restores to them their natural and necessary food. It is not doubted that there is a peculiar organisation fitted for these extraordinary functions, and subservient to this peculiar phenomenon. Night is the season for common and temporary repose—the winter of the year for this extraordinary sleep.

II. In torpidity, the functions of respiration are completely suspended and at rest ; but as some torpid animals seem to pass into this state fat, and emerge “lean and ill favoured,” it may be inferred that a slow and peculiar substitutary function is exerted. Whether this fat is absorbed into muscle, or evolved in another form, through the medium of some slow process, has not been yet determined.

III. From the fact of torpid animals, as the hedgehog, dormouse, &c. wrapping themselves up into a ball with *dried* leaves, hay, or other *non-conducting* substance, we may infer that moisture or damp, as well as a medium very low in temperature, would be injurious or fatal : an insulation, and a defence against these, is thus provided. Sudden warmth might also, from its abrupt transition, cause this torpidity to merge in death ; as an elevated temperature, when incautiously applied, destroys the frozen limb.

IV. The predisposing causes of torpidity are cold, and want of food or proper nourishment ; and torpid animals instinctively provide against their advent. Abstraction of liquid may also be subservient to this phenomenon ; and to these may be added the absence of the stimulus of light and stagnation of air, or its slow currency and intercepted circulation.

V. Torpidity may be arrested or suspended by a proper temperature, and generous diet or nourishment, conjoined with free ventilation or currency of air. It is not improbable, however, that the character and habit of the animal may be thus changed, and perhaps the natural term of its life abridged. We cannot doubt that a *periodic electric change* is that which summons them to awake from this wonderfully protracted sleep.

CHAP. VIII.

THE TESTUDO GRÆCA, OR COMMON TORTOISE. — AN
ACCOUNT OF THAT IN THE PALACE GARDEN AT
PETERBOROUGH. — ADDITIONAL PARTICULARS. —
THE DORMOUSE.

THE *testudo græca*, or common tortoise, may be occasionally met with in gardens in this country. Mr. Neill has had several at a time, and they move about either in his greenhouse or garden. One of several tortoises laid three eggs in the Rev. Dr. Patterson's garden at Montrose, who gave us one of them: it was spherical, the shell apparently thick, and altogether resembled a ball of marble. The size to which the tortoise sometimes attains is immense: we remember, some years ago, to have seen one, then semi-torpid, exhibited near Exeter 'Change, London, which weighed, if we recollect aright, *several hundred weight*. Its shell was proportionally thick, and its other dimensions bore a corresponding ratio: it was stated to be about 800 years old, but this must be considered fabulous; its size, indeed, and enormous thickness of the shell, were presumptive evidence that its age may have been of an antediluvian character; but no chronicles enrolled its years. In the library of the palace at Lambeth is the shell of a land tortoise, brought there about the year 1623: it lived until 1730, and was killed by the inclemency of the weather during frost, in consequence of the carelessness of a labourer in the garden, who, for a trifling wager, dug it up from its winter retreat, and neglected to replace it. Another

tortoise was placed in the garden of the episcopal palace at Fulham, by Bishop Laud, when bishop of that see, in 1628: this appears to have died a natural death in 1753. It is not known what were their several ages when placed in these gardens. That of which we are about to give an account, we saw in the palace garden at Peterborough, adjoining the Cathedral, in the summer of 1813. We were informed that its introduction into the garden was registered in a document in the archives of the cathedral, and its sustenance and abode therein provided for; but this seems to be incorrect. Its shell was perforated, in order to limit its range among the strawberry borders, of which fruit it was fond. The animal had its antipathies and predilections: thus it would eat endive, green pease, and even the leek, while it rejected asparagus, parsley, and spinage. In the early part of the season, its favourite pabulum seemed to be the flowers of the dandelion (*leontodon taraxacum*), of which it would devour *twenty* at a meal; and lettuce (*lactuca sativa*), of the latter a good sized one at a time; but if placed between lettuce and the flowers of the dandelion, it would forsake the former for the latter. It was also partial to the pulp of an orange, which it sucked greedily.

About the latter end of June, it looked out for fruit, when its former choice was forsaken: it ate currants, raspberries, pears, apples, peaches, and nectarines, the riper the better, but would not taste cherries. Of fruits, however, the strawberry and gooseberry were the most esteemed: it made great havoc among the strawberry borders, and would take a pint of gooseberries at intervals. The gardener told us it knew him well: his was the hand that generally fed it; and the animal would watch him attentively at the

gooseberry bush, where it was sure to take its station while he plucked the fruit. We could not get it to take the root of the dandelion, nor indeed any root offered, as that of the carrot or turnip: animal food was discarded; nor would it taste any liquid, at least neither milk nor water; and when a leaf was moist, it would shake it to expel the adhering wet.

This animal moved with apparent ease, though pressed by a weight of 18 stones; it weighed $13\frac{1}{2}$ lbs. In cloudy weather, it would scoop out a cavity, generally in a southern exposure, where it reposed, torpid and inactive, until the genial influence of the sun roused it from its slumber: when in this state the eyes were closed, and the head and neck a little contracted, though not entirely drawn within the shell. Its sense of smelling was so acute, that it was roused from its lethargy if any person approached even at a distance of twelve feet.

About the beginning of October (or latter end of September) it began to immure itself, and had for that purpose, for many years, selected a particular angle of the garden: it entered in an inclined plane, excavating the earth in the manner of the mole: the *depth* to which it penetrated *varied* with the character of the approaching season, being from one to two feet, according as the following winter was mild or severe. It may be added, that for nearly a month prior to this entry into its dormitory, it refused all sustenance whatever.* The animal emerged about the end of April, and remained for at least a fortnight before it ventured on taking any species of food: its skin was

* Dr. Patterson informed us that his tortoise used to sleep away the winter in some corner in the children's nursery. There must, therefore, be something more than *temperature* connected with torpidity.

not perceptibly cold*; and its respiration, entirely effected through the nostrils, was languid. We visited the animal, for the last time, on the 9th of June, 1813, during a thunder storm: it then lay under the shelter of a cauliflower, and apparently torpid.

It is very singular that the lettuce and dandelion should find such predilections with the tortoise: the lactescent juice of the former, from the opium it contains, is powerfully narcotic; and we have found that the extract. taraxici, applied to the sciatic nerves of a frog, acted in a similar manner to opium, by suspending voltaic excitement. It is also remarkable that these should have been rejected when the fruit season commenced, and the strawberry and gooseberry preferred; its antipathy to cherries is equally curious, and not less so its aversion to fluids. On the whole, that narcotics or sedatives should take precedence of all other kinds of food in the former part of the season, and those that act a different part in the animal economy toward the autumn, is certainly surprising.

This tortoise, so long an inmate in the palace garden at Peterborough, died on the second of April last. Having taken considerable interest in the fate of this remarkable animal, we wrote to the Lord Bishop of Peterborough, requesting the favour of a few particulars in its history, and had the gratification to receive from His Lordship the following interesting communication, which we feel much pleasure in adding to our personal observations, while we acknowledge the prompt courtesy with which it was made:—"The

* Dr. Davy took the temperature of the *testudo geometrica* at Cape Town, in May: air 61° ; the animal $62^{\circ}.5$. At Columbo, in Ceylon, on the 3d of March, the temperature of a larger specimen was 87° , while the air was 80° .

tortoise, a native of the south of Europe, was in the possession of a respectable individual (the then chapter clerk) of this city, in the year 1746, when it was reputed to be between fifty and sixty years old. It was presented by him to the Bishop of Peterborough, and has probably been about eighty years an inhabitant of the palace gardens, where the present bishop erected a shed for its better protection in the winter. It prepared with the first symptoms of cold weather to bury itself, and was then removed to the shed : it remained torpid till the return of settled spring weather, when, as soon as it rose to the surface of the ground, it was taken out, and left at liberty in the kitchen garden ; when, besides a panful of bread and milk prepared for it every morning, it fed upon lettuce, dandelion, and such fruits as were within its reach — but of lettuce and dandelion it was particularly fond. It was supposed to know the voice of the gardener, who usually brought its bread and milk. It was very susceptible of changes in the atmosphere, and showed its enjoyment of heat by the comparative agility of its movements and its increased readiness for food. For many years it had the use of only one eye, the lid of the other being closed in consequence of a blow from a spade whilst under ground. This eye was restored during the summer of 1826, and was apparently as perfect as the other till the time of its death. As soon as it showed itself in the warm weather of March, it was evident that it was in a very sickly state ; the head was unnaturally forced forward and upward, and though it took food, it did not masticate or swallow it. In a few days it died. Upon opening it, a great quantity of mucus was found in the œsophagus. It was a female. The muscles by which it was enabled to force its head forward were remarkably strong. Its strength

when alive was such that it bore the weight of a man. In 1826 it weighed 9 lbs."

In reference to the tortoise we find similar attestations in "The Natural History of Selborne:"—"it discovers as much solicitude about rain as a lady dressed in all her best attire, shuffling away on the first sprinklings, and running its head up into a corner: it is an excellent weather-glass; for as sure as it walks elate and on tip-toe, feeding with great earnestness in a morning, so sure will it rain before night." Our author thus verifies what we ascertained from personal observation and experiment:—"When it first appears in spring it discovers very little inclination towards food, but in the height of summer grows voracious, and then, as the summer declines its appetite declines, so that for the last six weeks in autumn it hardly eats at all. Milky plants, such as lettuces, dandelions, sow-thistles, are its favourite dish."

As a proper sequel, we may add a few remarks on the dormouse.

In the beginning of 1824, we received two dormice from a friend in Derbyshire, and commenced a series of experiments on the temperature developed by the skin. One of these was accidentally lost, having escaped from confinement; and we were shortly afterwards necessitated, from various avocations, to resign the prosecution of our experiments with the other. The following is a note of the temperature observed under different circumstances:—

31st January, 1824, at 25 minutes past 7 P.M., air of the room, 48° Fahrenheit; temperature of the dormice under the breast, 103° F. We soon after lost one of the prisoners. On the 14th February, at half-past 8 P.M., air, 51° F.; temperature under the breast, 62°.5. *The animal semi-torpid.*

	Air.	Under breast.	
Feb. 15. at 1 h. 15 min. P. M.....	46°	104°	
... .. 8 h. 30 min. P. M.....	47°.5	 69°	Semi-torpid.
... .. 3 h. 30 min. P. M.....	52°	102°.5	
... 19. ... 2 h. P. M.....	56°	 99°	
... 21. ...10 h. 30 min. P. M.....	54°.5	102°	
... 22. ...12 h. 30 min. P. M.....	57°	 97°	

On the 14th and 15th of February, the dormice were roused from their apparent death by heat, cautiously applied. The box which contained them had a partition: one compartment was supplied with fresh moss, well dried, in which the animals reposed during day, having formed for themselves a somewhat elliptical nest. Two openings, with slides, conducted into their outer court, where the dormice had their food prepared for them, consisting of wheaten bread (sometimes softened with water) and a basin of milk: great attention and care were bestowed on them, and the food daily supplied. The sliding pannels were shut when these compartments were cleaned, it being easy to expel them from the one to the other, and thus prevent their escape. Though their cage was frequently in darkness during the day, the *night season* was the exclusive period in which they took food: one of them adopted a singular expedient when the liquid was too low in the basin, it dipped in its brushy tail, and in this way transferred the milk to its mouth. When dormice are torpid, they are rolled up like a ball, and may be tossed into the air without discovering any motion or change. By keeping them in a proper temperature during the winter, their brumal torpidity may be entirely prevented; but they will not outlive the following year. They are fat and in good condition when they enter into torpidity, but issue from this state miserably lean. Our dormice were extremely timid, yet they may be so tamed as to run about the table and lick

the hand that feeds them. As to their sense of hearing, we found them peculiarly affected by the higher notes, and their eyes were, like those of albinos, injured by strong light and exposure to day.

CHAP. IX.

MIGRATION OF BIRDS. — SWALLOW SUBMERSION AND
MIGRATION. — THE CUCKOO. — THE STORK. — THE
NIGHTINGALE. — STARLINGS ON THEIR RETURN
FROM MIGRATION. — MIGRATION IN THE INSECT
WORLD — BUTTERFLIES. — THE LOCUST. — CONTEM-
PORANEOUS PHENOMENA. — INSTINCT. — CONCLU-
SION.

THE migration of some birds is a very curious part of their natural history, and it is an essential one: — the fact is indubitable, but the solution of the problem, in reference to the *predisposing cause*, is not easy:—

“ Who bids the stork, Columbus-like, explore
Heavens not its own, and worlds unknown before?
Who calls the council, states the certain day,
Who forms the phalanx, and who points the way?”

As is the case with torpid animals which cannot migrate, migratory birds retire *before* the severe season has chased the insect race into their cocoons and chrysalis forms. They take their departure while warmth yet animates the atmosphere, and insects dance in the sunbeam or flutter over the mantled pool, — the excitement, therefore, must proceed from some subtile principle, and yet the change of clime must be linked with the question of a supply of food. “ Not one of these is forgotten,” before HIM without whose permission “ not a sparrow falls.” Such a presentiment, therefore, was essentially neces-

sary to fulfil the end of their being; this instinct knowledge imparted by a mysterious power was therefore superadded, and thus gifted by Providence,

“ They reason not contemptibly.”

On this subject the most absurd notions have long prevailed, and submersion and torpidity were substituted for migration. Pliny supposed that swallows retired to the recesses of mountains, and reposed in winter without feathers — a period when of all others they most required their plumage. The west wind, as that contemporaneous with the arrival of the swallow, was called “Chelidonian;” and three islands over against Mount Taurus received their names in conformity with their being the supposed brumal retreat of the swallow.

The physiology of birds is certainly utterly repugnant to the idea of the submersion of swallows, and sets all analogy at defiance: the *leptura micans*, however, is an apparently curious exception; for it seems to descend by the stem of some rush or other aquatic plant to deposit its ova in the mud of the pool. Our swallows have been seen to congregate, take their departure, and cross the Mediterranean towards the coast of Africa; and at that season of the year when they are no longer seen in Britain, they have been observed in Senegal and the adjoining regions: — after the autumnal departure, Adanson found them wintering there. The fabulous idea, however, of their submersion, was entertained by Klein, Daines Barrington, and Linnæus, though on the most insufficient grounds. Linnæus even described their previous solemn assemblage on reeds or on the banks of rivers, and warbling their swallow song before they

descended into their watery sepulchre. Swallows are known to appear earlier and depart later in southern than in northern Britain. Mr. Forster observes, "it is hardly to be supposed that they would assemble together merely to hide themselves." * Adanson states, that on the 6th of October, on the African coast, four swallows alighted on the rigging — now the *hirundo rustica*, or common house-swallow, leaves Britain about this time; — and the same naturalist tells us, that these birds do not build nests there as in Europe, but roost every night on the sands on the shore, nor do they appear in Senegal until after their disappearance in Europe. Sir Charles Wager informs us that in one of his voyages homeward an immense flock of swallows settled on the ship. Every rope was covered with them, and they clung to one another like a swarm of bees. "We find," says Sir William Jardine, "torpidity occurring among animals, fishes, the amphibiæ, and reptiles, and among insects, but we have never found any authenticated instance of this provision among birds. Their frames are adapted to a more extensive locomotive power." The annual migration of birds seems to be more general in North America than in Europe from the greater inclemency.

The calendar of return in the stork, or the cuckoo, or swallow, is not founded either in solar or sidereal time, its date seems based in meteorology: sometimes the appearance is earlier and sometimes later in the season; but "intelligent of seasons," this period always harmonizes with a certain fixity in the weather — it is a point on which no mistake is made; they "know their appointed time." What vision in foreign lands has communicated to our aërial *voyageurs* that the va-

* "Brumal Retreat of the Swallow," London, 1813, p. 17.

riable vicissitudes of our high latitudes have settled into spring? None of these are lulled to forgetfulness by solar animation and an evergreen livery. They require no alarum to awaken their vigilance and summon them to depart. "They know their appointed time." In vain does the perennial hum of insect life tempt the swallow to stay; she is deaf to the siren charmer, and hastens to occupy her place in the calendar of her destinies. The direction of her flight is not the least wonderful in the history of migration. Instinct wisdom accomplishes what reason and experience illuminated by science achieved after the lapse of ages. The swallow has no compass for her guide; and the stars are useless, since another hemisphere is there revealed. The carrier pigeon flies at the rate of 50 miles an hour, but the velocity of the swift has been calculated at 250 miles an hour; and Mr. Montagu in his Ornithological Dictionary says that the swift (*hirundo apus*) "can and does suspend itself in the air for fourteen or fifteen hours together;" and really, except on the wing, we know not a more helpless creature. At this calculation it would in fifteen hours fly over a space of 3750 miles, and might therefore leave England at 6 A. M., ere insect life were well awake, and at noon be fluttering round the palm trees of Africa. We have seen the swallow (*hirundo rustica*) in Italy, after their disappearance in this country, and two once settled on the rigging of our vessel in the Mediterranean. They have been seen at sea in numbers; and the reason why they have not been more frequently observed is, that, whether in their exit or return, *night* is in all probability the period of migration; and the loftiness of their flight, where no local causes concur to disturb their progress, would render them invisible to the eye of the spectator. — "On a calm

bright evening in November, I have heard high in the air the redwing and the fieldfare on progress to a destined settlement; manifested by the signal notes of some leading birds to their scattered followers. These conductors of their flocks are certainly birds acquainted with the country over which they travel, their settlements here being no promiscuous dispersion." *

In Jenné, we are told by René Caillié, in his Travels to Timbuctoo, there is a mosque built of earth, surrounded by two massive but not high towers, rudely constructed though not large. It is abandoned to thousands of swallows, which build their nests in it. In all probability, this is a very different species of swallow from the common swallow (*hirundo rustica*), which builds its nest in Britain. It is now nearly a century since the swallow has made its appearance so early in Britain as the present season. In 1736, they were seen on the 30th of March, on which day they were also observed in the present year. In consequence of the heavy fall of snow, they entirely disappeared on the 1st and 2d of April, and we did not observe any till the 17th of that month, when we noticed a good many in the vicinity of Hereford.

"The swallow," says Sir H. Davy, "is the joyous prophet of the year, and the harbinger of the best season; he lives a life of enjoyment amongst the loveliest forms of nature; winter is unknown to him, and he leaves the green meadows of England in autumn, for the myrtle and orange groves of Italy, and the palms of Africa. Even the beings selected for his prey are poetical, beautiful, and transient. His instinct, which gives him his appointed seasons, and which teaches him always when and where to move, may be

* "Journal of a Naturalist," 1829, p. 211.

regarded as flowing from a divine source ; and he belongs to the oracles of nature, which speak the awful and intelligible language of a present Deity." *

There is, perhaps, no bird whose note is more welcome than that of the cuckoo : it is the voice of spring, and in its intonation is heard the promise of the year. After its visit to savage tribes and an exotic clime, the cuckoo returns to Britain as its home, where its offspring may be sheltered and reared in safety. Though the phenomenon may be rare, we remember to have heard its note *at midnight* between Douglas and Castleton in the Isle of Man ; it is now some years ago ; the moon was bright, and "cuckoo" was often repeated from trees in the distance. Among migratory birds we know none more interesting than the stork, and its history is full of almost romantic detail ; it is linked with the heron and the crane, though itself alone. The heron is a very graceful creature, and some of its attitudes extremely picturesque : when perched on the edge of some antique marble fountain, there is scarcely a happier image of contemplation. Its form is not only graceful, but it is as still and motionless, as if life had been suddenly congealed in its veins at the moment its finest attitude had been assumed, and the charm hermetically preserved ; we have watched this unbroken stillness for hours together. The heron seems, too, a docile and a curious bird : we have seen one near Bridgnorth, whose manœuvres were quite amusing. When the drawing-room window was opened (on a level with the garden), it would stalk in with some share of majesty, and after a walk up and down the room, would march boldly up to the fireplace in cold weather, and expanding its wings, first present one side and

* "Salmonia," p. 79.

afterwards the other, alternately, then turn round and warm the plumage of the back ; there was, in fact, art and method in its whirls and semicurves, which never failed to interest attention in the exhibition.

Mr. Davies has supplied us with the following account of " the adjutant," linked by natural affinities with this family. " That singular species of the stork, called by our soldiers, on account of its stately and military march, the adjutant, is exceedingly common in Hindustan, particularly in the cantonments, to which places it is irresistibly incited by the great quantities of animal food used by the Europeans. Fort William, Calcutta, may be said to be infested by it ; though the annoyance occasioned by its voraciousness is more than compensated by its predilection for serpents and other venomous reptiles, whose increase, if not retarded by the adjutant, would be a more serious evil. Scarcely can a dinner pass from the culinary regions to the higher apartments without being pounced on by these voracious birds ; and often I have seen families despoiled in a moment of their expected aliment by these unceremonious and unwelcome guests : the size of the joint presents no difficulty to the seizure. I have been told that the capture and deglutition of a leg of mutton in this manner is a very common occurrence ; and though I cannot say I have witnessed this rapid manœuvre performed, yet from my remembrance of the size of joints of Indian mutton, and the rapaciousness of these birds, I cannot doubt the truth of what I have heard. They so completely besiege a room in which there are any symptoms of good cheer, that joints or morsels thrown from the apartments (generally elevated above the ground-floor) are caught, long ere they fall to the earth, by some fortunate competitor, whose dexterity and generalship for a moment brings on him the

clamorous indignation of his companions, who follow him, struggling to retain his prey, with loud complaints and vigorous attempts to make him disgorge. The common soldiers, who are fond of deriving amusement from the epicurean propensities of this bird, have a very successful way of making him a prisoner on discretion for some time. They append a piece of flesh to the end of a rope, and throw it in the air; the flesh is swallowed without scruple, and the poor bird, unwilling to disgorge his food, though the price at which he purchases it is his liberty, is thus compelled to walk in procession, and swell the triumph of his conqueror. The ludicrous appearance of the adjutant in this situation is scarcely imaginable. His walk, at all times staid and majestic, is now peculiarly solemn: he looks like a knight-errant of ancient chivalry, unarmed and in chains, deprived of every thing but his sturdy pride, which even now permits him to defy his conquerors with contemptuous gaze. This singular bird sleeps amidst shallow waters, to which it retires to be safe from the attacks of beasts of prey: as soon, however, as the dawn promises the joyful return of the military breakfast, they issue from their aquatic dormitories, and with clamorous importunity wing their way to the barracks, where they stalk in solemn grandeur till the offals are distributed, or they succeed in their predatory attempts on some viand insufficiently protected against their marauding practices."

The white stork (*ciconia alba* of Ray) is the most interesting of the species, and its aptitude as a selected point in sacred writ will be found in its natural history. Its biography comprises a history of usefulness and affection. When its food, such as insects and reptiles, disappears, and the brumal months draw on apace, the subject of our remarks seek a more temperate clime,

and returns northward in the genial period of spring. It passes its winter in North Africa, or Egypt, chiefly in the latter ; from whence it migrates during summer to France, Holland, Sweden, Germany, Switzerland, and Poland, rarely to England or to Russia. Like the heron, it is a very picturesque creature : poised on one leg, it is the very death-like attitude of breathless repose, and the image of graceful thought. Its step is slow, solemn, and measured, moving in conscious elegance. These birds leave Europe about the beginning of August, and the “ note of preparation ” occupies several weeks’ consideration in deliberate and legislative assemblage ; the period arrived, the collective body, to the number of many hundreds, mount at once into the air, and are soon lost to observation in the majesty of their flight. In the months of March and April they return to Europe in smaller bands.

These interesting creatures have ever been regarded with kindly and welcome feelings ; and the trust they repose in man, while it merits his protection, seems not misplaced. Thus the stork, in some towns of Holland, may be seen walking at his ease, and undismayed at the presence of man, along the busy streets of a crowded town ; and obtaining its food on the verge of rivers, canals, or fens. They are not only passively harmless, but positively useful ; and even the hallowed charm of moral virtue invests them. In ancient Egypt the stork was esteemed sacred ; second only to the ibis, and was shrined among the divinities of that land of gods. Congenial feelings are kindled in its favour wherever it takes up its residence, whether in Africa or the East, Switzerland or Holland : in the latter it builds on the house-top, amid the din and bustle of population, or else selects the summits of the loftiest trees. Their house-top nest in Holland remains undis-

turbed for many years, the owners returning to the cherished spot in their "appointed time;" and the joy manifested on their taking possession again, and their attachment to their compassionate hosts, is a very anthem of joy and gratitude. The history of the female stork which perished in the conflagration of Delft is a trait of affection "strong as death:"—repeated and unsuccessful were her efforts to carry off her unfledged young, and she chose to perish with them rather than leave them to their fate alone—a *suttee* worthy of record. Nor is this an insulated luminous spot in their remarkable lives, there are many other incontestable proofs of similar affection and devotion.

The parent birds are a model of excessive attachment to their helpless offspring: as soon as they are capable of exercising their pinions, their parents *bear them on their own wings*, and then lead them gently in circles round the nest. Hence the beautiful image of the Scriptures, "HE shall bear them up as on eagle's wings," thus literally true of the stork, — personified emblem of what is "lovely and of good report."

The nightingale leaves us generally towards the end of August or in September. The genus *sylvia* do not linger at farthest beyond the middle of October. Ere this the light of the glow-worm has waned and suffered its annual eclipse. The nightingale sometimes constructs its nest of *skeleton leaves*.

We were informed that a gentleman near Bridgnorth, who has particularly attended to the habits of the nightingale for many years, has fully ascertained that this bird *commences its migratory flight in the night*, and have been told by those who have kept nightingales for many years, that for a day or two before their usual and fixed period of migration they become restless, and beat themselves so violently

against the bars of the cage, that but for the precaution of lining the interior, these struggles might be suicidal. "Birds," says the "British Naturalist," "must roam in quest of food; nor is it a hardship, — it is a wise provision. Were they to remain, and had they access to the embryos of life in their then state, one season would go far to make the country a desert; and even the birds would be deprived of their summer's subsistence for themselves and their young."

On the 11th of December last, about half-past three in the afternoon, on the Derby side of Burton-on-Trent, we witnessed an immense assemblage of starlings returned from emigration. This gregarious flock sported in curves and eddies, then whirled *en masse*, then stretched far in a fine undulating line, — the line of beauty. Sometimes they rose to a considerable elevation, and then fell to a lower plane, and would occasionally form a dense aggregate, accompanied with a total obscuration and eclipse of the landscape beneath. There were more than thousands, — myriads in number. Their graceful curves, and serpentine play, and congregated phalanx, altogether constituted to us a phenomenon novel and interesting; while their reeling and sportive figures, ever varying, were of the most beautiful description, and exceeded all that art has ever accomplished in the mazes of the dance.

Migration is seen in the insect world, and even *butterflies* sometimes migrate. In the "Mém. de la Société de Phys. et d'Hist. Nat. de Genève," we find that an immense swarm of the painted lady (*papilio cardui*, Lin.), forming a column of from ten to fifteen feet broad, was observed in the district of Grandson, Canton de Vaud, in 1828. They appeared to have traversed the country with great rapidity from *north to*

south, not deviating from their course, and forming a compact body. This is rather remarkable, seeing that the larvæ of this insect are not gregarious, but insulated from their kind. Bonelli of Turin mentions a similar phenomenon. The multitude was immense, and their direction also from *north to south*. At night the flowers were completely clothed with them. Their numbers diminished towards the end of March. In the Memoirs of the Academy of Turin a flight of the same kind is stated to have been observed towards the close of the last century.

The migration of the *locust* is an event of terrible importance in the balance of nature, and the fate of kingdoms may be involved in it. On the wings of one of the locust family the Arabs discern some of their own characters, and a locust is thus made to address Mahomet:—"We are the army of the great God; we produce ninety-nine eggs: if the hundred were completed, we should consume the whole earth, and all that is in it." The prophet Joel describes their devastation in glowing yet correct language:—"The land is as the garden of Eden before them, and behind them a desolate wilderness."* The myriads of these creatures (*gryllus migratorius*) which sometimes congregate together, and the extent of devastation they produce, would scarcely appear credible were the facts not well authenticated. In August, 1747, a swarm of locusts entered Transylvania, and such were their numbers that they occupied *four hours* in their passage over the place: the width of the swarm was some hundreds of fathoms, and its density such as to exclude daylight and darken the sun; so that people could not see each other at a distance of twenty paces. The guards of the Red Tower fired at them to prevent

* Joel, ii. 3.

their ingress; but though whole ranks were mowed down, and the swarm divided where the balls and shot told, the chasm was instantly filled up again, and the mass proceeded. In the East governors of particular districts sometimes command the military with a train of artillery to take the field against them.

Our intelligent friend the Rev. Mr. Davies has kindly favoured us with the following remarkable account of a swarm of locusts which he witnessed, and it may challenge competition with any on record:—

“There are but few of the realities of life which afford to the observer the same ideas of magnitude and sublimity with which previous imagination has invested them. We are fascinated by the descriptions we read in our early and romantic days: we feed our love of the marvellous by perhaps an unconscious addition of circumstances, which, when the anticipated object is once presented to the eye, fade away, and by their unexpected absence as much depreciate the present object below its intrinsic value as by their flattering presence they had placed it above its just level in anticipation. Perhaps it results from the original dignity of the human soul that it is capable of creating an imagery which facts can never realise: perhaps from the perpetual disappointment in our expectations of grandeur and delight, we should learn that this sphere of existence was not appointed as the state where our faculties are to receive their due and legitimate fruition; but that another world alone can unfold to us those scenes of rapture which can fill and satiate our enlarged desires. To me, certainly not over sanguine in my expectations, disappointment has almost in every instance occurred on beholding for the first time some object of whose magnitude, or beauty, or sublimity, I had previously read. I know but one

exception, and that was in my first realisation of a flight of locusts. As far as my neglect of taking a memorandum respecting the time will permit me to be accurate, I think the first instance in which I beheld this famine-portending host was in 1810, at Caunpore, in the East Indies. Their approach was signified by the cloudy appearance of the heavens towards the north. As the invaders came nearer the sky became more obscure, till at length, when they might be said to be contending with us for the possession of our cantonments, they covered, or rather animated, the whole visible atmosphere with so dense and overwhelming a multitude, that it became suddenly as dark as the evening twilight. The elevation in which they moved appeared to be from about ten feet, to one or, perhaps, two or even three hundred feet above the earth; the whole of which height, in every possible direction, was so thickly occupied by these rapacious freebooters that it appeared impossible in any part to thrust a finger in the interstices between the bodies. This flight, which was from north to south, continued for the space, if I do not err, of three days, during which time, though moving with their usual rapidity, the cloud was equally dense. One fact struck me forcibly at the time, as affording a faint idea of the innumerable multitude of these creatures, that though the tired, and maimed, and wounded fell on the ground in such proportions that it was impossible to walk out for several days after without crushing as many of them as could lie in the space measured by four feet, yet this defalcation caused no apparent diminution in the invading army. Had I not seen the main body of the volitants I should have considered the prostrate lingerers to be the nearest approach to infinitude I could imagine; but I should think that these did not amount to the

proportion of one to a million of those which still maintained their career. I observed also that the wings which fell were proportionably much more numerous than the bodies; which made me think that Providence having supplied these creatures with four wings each, the additional pair could be used in those cases where fatigue, or pressure, or other contingencies, might deprive them of that pair which appeared to be of stronger fabric. Our only means of defence against this devastating host was to sound *gongs* and *tom-toms*: this means was resorted to very generally, and a most obstreperous symphony was performed, which had the desired effect of driving the unmusical barbarians to some distant land. Had they alighted in our vicinity nothing could be expected but a universal spoliation of all that was eatable: the harvest of a whole province could scarcely afford a single meal to such fearful numbers."

In 1748 a swarm of locusts came within twenty leagues of Vienna. One swarm was half an hour's journey in the width of the column; but after three hours' rapid flight the termination of its length could not be seen. In 593 the devastations of the locusts occasioned a famine in many countries. In 677 Syria and Mesopotamia were over-run with them; and in 852 a swarm visited the West. Their daily marches were computed at twenty miles, with intervals of rest. They seemed to be headed by a captain and commander, — and what a host! The winds drove them into the Belgic ocean; and the tide having cast their dead bodies on shore, a dreadful pestilence was the consequence. In 1271 all the corn fields about Milan were destroyed, and in 1339 those of Lombardy. In the summer of 1815 we observed considerable quantities of dead locusts on the shore at Yarmouth, cast up by

the tide, and ascertained the species to be the true migratory locust.

The *gryllus cristatus* is the largest of the locust tribe, and at least five times the size of the *gryllus migratorius*. It is sold in the markets of the Levant as an article of food, and is likely to have been that on which the Baptist subsisted in the wilderness of Judea: it was permitted in the Mosaic ritual, and we think it absurd to suppose it to have been the *hymenea courbaril*.

The Rev. W. T. Bree * informs us that the bursting of alder buds is contemporaneous with the period when eels leave their brumal retreats; and the return of snipes from their migration simultaneous with the flowering of certain wild plants, such as the *draba verna* and others. It has been ingeniously suggested by Mr. Lees that the flowering of a plant might be the harbinger of the advent of some bird, and the opening blossom of a plant be announced by the appearance of an insect. These contemporaneous events are very interesting, and if accurately recorded may eventually conduce to the solution of a problem curious in itself, and interesting to the naturalist and lover of nature's loveliness. The question, however, will still recur in full force, who or what carried the interesting intelligence to the swallow or the stork, when far away from Britain's isle and Europe? The sympathetic chord, whatever it be, vibrates from pole to pole, and encircles the globe. The migration of birds seems regulated by a changed electric state of the earth or air. This is Heaven's electro-magnetic telegraph, which announces the intelligence to a distant clime, and none so universal or so swift. It is this which tells our absentee feathered race that the spring has indeed returned, and the

* Mag. Nat. Hist. No. II. p. 17.

“time of the singing of birds is come,” — that they may now safely return and join their notes with the woodland choir. A mere change of temperature does not amount to the full estimate required here, — for how can that penetrate the clay cearment of the Canada jumping mouse, and other animals, surrounded by and deeply buried in non-conducting media, as the *marmot* and others. The cause that rouses from torpidity is doubtless an electric one, and in the migration of birds the same cause is in full operative influence.

We certainly know not what *instinct* means, and therefore cannot give its portraiture. In many things it is the image of reason, and its counterpart. In some cases it even transcends the powers of reason; for it occasionally seems to catch a glimpse of futurity, and be its prophet. Still its mechanism is limited; while reason has capabilities endowed with infinite expansion, “grows with our growth, and strengthens with our strength.” Nor can we describe what may be the majesty of its powers, when we shall have “shuffled off this mortal coil,” and it is unshackled by resistance, — its vision unclouded.

“Creation needs no new fiat; but the succession of events, throughout all her works, depends on laws which are unerring, because they are not imposed by any thing from without, but are the very nature and constitution of the beings that appear to obey them. It is this which makes nature so wonderful; which so stamps upon it the impress of an Almighty Creator: — its parts and phenomena are millions; the primary Power that puts all in motion is but one.”

“Yea the stork in the heavens knoweth her appointed time; and the turtle, and the crane, and the swallow, observe the time of their coming.” *

* Jeremiah, viii. 7.

CHAP. X.

LIGHT EMITTED FROM VEGETATION.—EXOTIC LUMINOUS INSECTS, PAUSUS SPHÆROCEROS, AND OTHERS.—ELATER NOCTILUCUS.—FULGORA LANTERNARIA AND CANDELARIA.—INDIAN GROSBEAK.—LAMPYRIS NOCTILUCA, OR GLOW-WORM, HABITS, ETC.—LAMPYRIS ITALICA.

LIGHT is derived from a variety of sources, but the present enquiry embraces the question as connected with the living system, chiefly the insect world, in some of which it forms a very wonderful investiture. Decayed wood and some plants emit a phosphorescent light; and the potato, when in a heap, is said to be sometimes luminous. Some of these species of illumination are of an electric kind; others are owing to the occasional presence of luminous insects, as the *scolopendra electrica*, &c.; and sometimes, we have no doubt, to the presence of luminous ova, or parasitic luminous animalculæ: the increase of temperature on the decomposition of vegetable matter might be a sufficient cause of evolution. Plants of the *rhizomorpha* kind are discovered often luminous in mines. Mr. James Ryan informs us he has met with plants in mines almost sufficiently luminous to read by; and the counsellor Erdmann thus describes the luminosity of the *rhizomorpha*, in one of the coal mines near Dresden:—“ I saw the luminous plants here in wonderful beauty; the impression produced by the spectacle I shall never forget. It appeared on descending into the mine as if we were entering an enchanted castle, the abun-

dance of these plants was so great, that the roof, walls, and pillars were entirely covered with them, and the beautiful light they cast around almost dazzled the eye. The light they give out is like faint moonshine, so that two persons near to each other could readily distinguish the outlines of their bodies. The light appears to be most considerable when the temperature of the mines is comparatively high." Mr. de Luc mentions and describes a luminous phenomenon he observed in cavities in the granitic mountains which form the boundary line between Bayreuth and Bohemia; a very pretty mass it appears lines these cavities, exhibiting a chatoyant lustre of an emerald green colour. A correspondent in the Magazine of Natural History mentions a similar phenomenon near Penryn, Cornwall, which possessed a most beautiful emerald green colour, accompanied with a phosphorescent brilliancy, and proceeded from a small moss much resembling the *dicranium taxifolium*. What have been called "shooting stars," and found sparkling on the ground, seem to be the *tremella meteorica*, and have been observed apparently to fall from the air. Thus on the night previous to the battle of Brandywine, a shooting star was observed by one of the sentinels to fall at no great distance; it proved to be a sparkling gelatinous mass.

Among exotic luminous insects we may enumerate, as the most remarkable, the *pausus sphæroceros*, *elater noctilucus*, and two species of fulgora. The *pausus sphæroceros* * was caught by Afzelius, in 1795, at Thornton Hill, in the vicinity of Sierra Leone, having fallen from the ceiling of the house on the table: it appears to live in wood, and to prefer new built

* See Plate, fig. 3.

houses. Afzelius says, “happening to stand between the light and the box (in which the insect was confined), so that my shadow fell on the animal, I observed, to my great astonishment, the globes of the antennæ like two lanterns spreading a dim phosphoric light.”

The *elater noctilucus* is called *cocujas* in South America, where it is not uncommon: it is about an inch and a half long, and of a brown colour, with the thorax marked on each side by a smooth yellow transparent spot, highly luminous, and diffusing so brilliant a light at night, that a person may, in a favourable position of the insect, see to read the smallest print. Besides these, however, there are two luminous spots beneath the elytra, only visible, of course, when the insect is on wing, and it then appears studded with four rich and vivid gems of a blue lustre; in fact, the whole body seems a flood of pure light. In the West Indies, particularly St. Domingo, the natives employ these insects to give light in managing their household concerns. In travelling, they are wont to attach one to each toe; and it is stated that in fishing and hunting they require no other light. Pietro Martire informs us, that the *elater noctilucus* serves the natives of the Spanish West Indies, not only as a light to illuminate their houses, but to extirpate the gnats: on introducing the fire-flies, the gnats become their prey. On festive days, these fire-flies are collected and attached to their clothes and horses; and, according to the same author, the luminous matter is sometimes rubbed over the face. We are told by Mouffet, that the appearance of the tropical fire-flies, on one occasion, led to a singular result. When Sir Thomas Cavendish and Sir Robert Dudley first landed in the West Indies, the flitting

and moving lights of these insects in the woods impressed them with the idea that the Spaniards were advancing, and they returned in consequence to their ships. Eight or ten of these insects put into a phial will yield a light equal to a common candle; and it is said that this was the only light used by the natives of Hispaniola, &c. prior to the arrival of the Spaniards. The *elater noctilucus* will be found figured, if we rightly remember, in Rees's Cyclopædia. It much resembles the *elater porcatus*, but is more slender, and has two round marks on the thorax like *elater oculatus*: the *elater ignitus* is another luminous species of this genus.

We are informed that in South America, by way of amusement, small bits of lighted wax taper are affixed to the heads of some of the larger *scarabæi*; and thus equipped, they are prompted to march into the room to startle some evening party: such are called *cocujas*. The *scarabæus herculis*, a native of South America, is five or six inches long, and seen in numbers on the *mammæa americana*. A few of these insects, thus illuminated, would certainly have an odd appearance.

The *fulgora lanternaria* *, Peruvian lantern-fly, or the fire-fly of the West Indies, measures nearly three inches and a half from the tip of its lantern to that of the tail, and about five inches and a half from tip to tip of the expanded wings. The body is divided into several annular segments: the projecting head nearly equal in length to the entire body of the insect, is oval, inflated, and slightly curved or arched upwards. The ground colour is a fine yellow, with a deep tinge of green in some parts, and marked with numerous bright red and brown variegations in the form of stripes or spots. The wings are large,

* See Plate, fig. 1.

somewhat yellowish, and very elegantly varied with brown undulations and spots : the lower pair are decorated by a large eye-shaped spot, the iris or fringe of the spot being red, and the centre half red and half transparent white : the head or lantern is a pale yellow, with longitudinal stripes. Such is a description of this beautiful insect, thus quaintly expressed by Dr. Grew* : — “ It is about three inches long, and thick as the ring finger ; the eyes, for bignesse of his body, very small, of a dusky colour, yet glossy and spherical, looking just like two brown seed pearls ; under these stand two small round parts, open at top, which seem to be the roots of a pair of horns, unless any will conceit them to be his eyes. That which beside the figure of the head is most wonderful in this insect, is the shining property of the same part, whereby it looks in the night like a little lanthorne (*lamphorne*), so that two or three of these, fastened to a stick, or otherwise conveniently disposed of, will give sufficient light to those that travail or walk in the night.” The lantern-fly is a native of Surinam, and many other parts of South America, and during night diffuses so powerful a light that it is often employed by the negroes to conduct them on their way ; indeed, from the intense heat of the day, travelling by night in the Brazils, &c. becomes an object of necessity as well as of choice. The Chevalier de Mascarenhas informs us that it is common in such cases for the negro attendants to cut down sticks from the bamboo or orange trees, and attaching a few of these interesting insects to the tip of the staff, the illumination thus obtained, when carried before the party, yields quite sufficient light for their guidance ; that

* “ Catalogue of Natural and Artificial Rarities,” &c. London, folio, 1685. p. 158.

thus equipped, he has travelled by night through many districts of the Brazils, and threaded the woods of South America. Thus had the aborigines of South America, in all times past, provided for them, by Divine Beneficence, a living lamp, which, supplied from itself, required neither oil nor gas to feed it, and ever bright, needed no hand of art to trim it: it was kindled at first by that BEING who said "Let there be light," and it was so. And our friend informs us, that when the hedges, chiefly formed of some species of the genus *rosa*, are illuminated by these gems of living light, it is a truly brilliant scene. He tells us also, that the light intermits, as in the glow-worm, as if it were occasioned by the respiratory organs or the movement of the abdomen; hence there can be little doubt that it is connected with the circulation of the blood.

Madame Merian describes her surprise on first seeing this light. Some of these it appears had been imprisoned in a box, but the noise they made awoke her; and on opening the lid to see what was the matter, one flash of fire after another issued from the box. *Lucifer*, or *porte-lanterne*, is the name given to this insect by Mad. Merian, and is figured (pl. 49.) in her "Insects of Surinam." The head is a translucent mass, and the light shed by it so great, that according to Mad. Merian it would not be difficult to read a newspaper by it. "Un livre d'un caractère pareil à celui de la Gazette d'Hollande," — these are her words. She does not pretend to draw the insect by its own light, as Dr. Darwin has made her do.

Roësel gives us a beautiful representation of the insect. The truth of these exquisite colours and shadings has been questioned by De Geer; but we are of opinion, that, so far from exceeding the truth, they fall

infinitely short of the beautiful original. Le Chevalier M. informs us that the annular segments of the insect, attached to fine metallic thread, formed into armlets and necklaces, are worn by the higher ranks of the Brazilian ladies, and that their splendour is exquisite and brilliant. Such a necklace will cost from 10*l.* to 14*l.* sterling.

The *fulgora candelaria* *, a native of China, is a much smaller species than the other. It sometimes measures near two inches long, and two and a half inches broad when the wings are expanded. It is not an infrequent insect in cabinets : we possess a great many specimens. The head and curved horn are of a fine reddish brown, occasionally mottled with white specks somewhat mealy. The eyes and proboscis are translucent, and curiously, as we have seen, reflect a nebulous image of the candle. The under wings are orange-coloured, with broad velvet black tips; the superior wings are decorated with yellow spots and bars, reticulated with diffused squares, &c. We are informed by the Rev. Mr. Davies of Hereford, that in India the *fulgora candelaria* illuminates the hedges with a faint purple light, as is the case also in South America, from three to five feet high; and he observed the hedges on the banks of the Ganges, under the Rajemahal mountains, about 300 miles above Calcutta, particularly brilliant. This is the general altitude we have observed of the *lampyris italica* in the north of Italy; and being the usual height of nocturnal insects, it seems probable that our view is correct. The apterous glow-worm yields a yellow light; but the *lampyris italica* on the wing evolves a *purplish* gleam, which appears to be the case with the fire-flies of China. This is the insect selected

* See Plate, fig. 2.

by the *tenawhit* to decorate its nest — perhaps to scare some nocturnal spoiler. There is, besides these, the *fulgora diadema*, which much resembles the latter species, and is a native of tropical climes.

The Indian grossbeak, alluded to by Dr. Buchanan, builds its pendent nest on the highest tree, chiefly the palmyra; and this tree is particularly selected when it happens to overhang a well or rivulet. These curious nests are woven with grass in the shape of a calabash, only more oblong; and it thus depends from some branch, swinging in the wind, the cradle nest rocking the infant brood. The nest usually consists of several compartments, and it is illuminated in the interior with fire-flies (*fulgora candelaria* *): these are attached by clay or some other adhesive substance. What this singular investiture means, it would be no easy matter to determine: whether the bird has some passionate fondness for an artificial illumination of its abode, or it is the subject of amusement, it would be difficult to determine. If it merely served for food, it does not seem very likely it would glue them to the walls of its tenement. The butcher-bird, however, impales his victims alive on spines of thorns; and the caddis-worm makes no scruple occasionally of cementing to his case a *helix fluviatilis*, and its living tenant. This interesting bird is very tractable and docile, and may be easily taught to repeat many little tricks; such as, at a specific signal from the lover, to bring him the golden *ticas* from between his mistress' eye-brows, or even carry her a note; and we have been told by a friend, many years resident in India, that this little bird is very tame, perching on the finger and accompanying its protector, fond of being caressed. Dr. Claudius

* See Plate, fig. 2.

Buchanan, in his "Christian Researches in Asia," mentions writing one of his letters under the nest of this bird, which had lighted it up with fire-flies, "as if," he facetiously remarks, "to see company."

Of luminous insects in this country, the *lampyris noctiluca*, or glow-worm, and the *scolopendra electrica* and *scolopendra phosphorea*, are the most conspicuous and common. Kirby and Spence state that some insects, not commonly suspected, may, under peculiar circumstances, evolve light, such as the mole cricket (*gryllus gryllotalpa*); and, on the authority of Dr. Sutton, it is even conjectured that the *ignis fatuus* may be of this description. We have elsewhere described a phenomenon of this kind witnessed by us in Hertfordshire last summer, apparently connected with the presence of a luminous insect.* The *scolopendra electrica* we first found in Huntingdonshire, and the *lampyris noctiluca* most abundantly in the vicinity of Oswestry, which indeed seems a prolific region for them. It had been supposed, that the property of emitting light was confined to the female in the *lampyris noctiluca*. Ray first pointed out that the male insect also yielded light, and the circumstance was confirmed by Geoffroy and Müller. In the males of *lampyris splendidula*, and *lampyris hemiptera*, the light is distinct, and may be recognised when the insect is on the wing, but is of inferior brilliancy, and confined to minute points. The glow-worm, in the case of the larva and perfect insect, have different degrees of luminosity, and sometimes may have been confounded together. It has been observed, that the females of the glow-worm can occasionally conceal or eclipse their light — and it may be to secure themselves from becoming the prey of the

* See "A Treatise on Atmospheric Electricity," Whittaker, 1830, 2d edition.

nightingale or some other nocturnal bird : Mr. White, indeed, thought that they regularly extinguished their torch between the hours of eleven and twelve. The light with which it is invested, may perhaps occasionally prevent its insect enemies from making an attack on it — as the wolf, and other ravenous beasts of prey, are deterred from making an approach on travellers at night when encircled by fire. Though, it must be admitted, that many of the species of the *lampyris* are without wings, and want even elytra — the female of the *lampyris italica* is said to be a winged insect.

The *lampyris noctiluca* *, or glow-worm, is sufficiently known as a native of Britain — at least the female of this insect, — for the winged male is not so commonly recognised. The female is of a dull earth brown colour above, and beneath tinged of a somewhat rosy tint, with the two or three last segments of a pale sulphur colour; and from these the light emanates. The larva, pupa, and perfect insect, differ but little from each other, and *all* of them are luminous: the light, however, is most brilliant in the last stage of the insect. According to the observations made by the excellent author of the “Journal of a Naturalist,” the glow-worm sometimes becomes, in all likelihood, the *bon-bon* of the toad. According to him the light of the glow-worm has sensibly diminished after the 14th of July, though deep in the herbage a clear steady light has been observed as late as August and September. It was observed as late on one occasion as the 28th of September, 1826, though very different in its sparkling from that of the summer months. “If the summer light,” he observes, “of the glow-worm is displayed as a signal-taper, the appearance of this autumnal light

* See Plate, fig. 4., male and female.

can have no such object, unless it serves as a point of union in their supposed migrations, like the leading call in migratory birds, or the summons of the war-whoop among Indian tribes."

The following observations on the glow-worm are addressed to the editor of the *Philosophical Magazine**: — "The female deposits her eggs in the month of June or July, among moss, grass, &c. These eggs are of a yellow colour, and emit light. After remaining about five or six weeks, the larvæ break their shells and make their appearance: at first they appear white, and are very small, but they soon increase in size, and their colour changes to a dark brown, or nearly black colour. The body of the larva is formed of eleven rings. It has six feet, and two rows of reddish spots down the back. It emits light in the dark: this light arises from the last ring of its body under the tail, and appears like two brilliant spots when attentively examined. The larvæ are seen creeping about and shining during the fine nights in autumn, and the light they emit is to direct them to their food. They feed on small snails, the carcasses of insects, &c. They frequently cast off their skins: after the expiration of about one year and nine months from their birth, they arrive at their perfect size. They then cease to eat, cast off their skin, and assume another appearance. The form of the perfect insect may be discovered through a thin skin that covers them. After remaining in this state two or three weeks (scarcely ever moving), they throw off their last skin, and arrive at perfection. The male then appears a perfect beetle, having wings, and wing cases. The female, on the contrary, has neither the one nor the other: she is

* *Phil. Mag.* vol. lviii. p. 53.

larger than the male, and of a lighter colour. It is the female that principally shines in a perfect state. Her light is far superior to that emitted by the larva, and arises from the three last rings of the body on the lower side."

The male, smaller than the female, is a winged insect, and supplied with wing-cases; and though Dr. Shaw seems to doubt whether the male be luminous, the fact is now sufficiently established. The male has toward the anal segment two brilliant fire spots: its light, when seen on the wing, is somewhat purplish. In the Phil. Trans. for 1684, Mr. Waller maintains the luminosity of the male, which was found by him at Northaw in Hertfordshire. In Italy the *belles* adorn their head-dress with the *lampyris italica*; and it appears that a similar practice prevails in India. The *lampyris italica* is figured in Olivier, No. 28., pl. 28., fig. 12.: in truth, the male of the *lampyris noctiluca* of this country bears so close a resemblance, that it is not improbable the insect may be the same; the greater atmospheric temperature varying the intensity of light in an Italian clime. Doubtless, too, what have been distinguished as separate insects, under the names *lampyris noctiluca*, *spendidula*, &c. are the females of the same insect; the one being the female perfect insect, and the other the larva. In Lombardy, Tuscany, &c. we have picked up glow-worms in no respect dissimilar from our own.

The Italians have a superstitious dread of these beautifully adorned insects; believing them to be the spirits of their departed ancestors. Sir J. E. Smith mentions that some Moorish ladies were taken prisoners at sea, and, until they could be ransomed, lived in a house beyond the city walls of Genoa: during the period of their stay, they were visited by

many of the respectable inhabitants of the city. On one of these visits, they found the house shut up, and the Moorish females in great grief and consternation. Some of the beautiful *lampyris italica* had found ingress into the house, and these brilliant guests were supposed to be no other than the troubled spirits of their relations. We remember one evening, on coming from Arcqua (celebrated for the tomb and former residence of Petrarch) to Padua, that all the hedges and shrubs were illuminated with myriads of these “diamonds of the night:” — the effect was very beautiful.

CHAP. XI.

THE GLOW-WORM.—OPINIONS ON THE LUMINOUS MATTER OF INSECTS. — THAT OF THE GLOW-WORM, AND CAUSE OF ITS EXHIBITION. — PHENOMENA ON ITS INTRODUCTION, AND THAT OF THE INSECT, INTO VARIOUS MEDIA.—OUR EXPERIMENTS AND CONCLUSIONS. — DR. CARUS'S DISCOVERY. — TO WHAT PURPOSE SUBSERVIENT. — CONCLUSION.

Numerous opinions have obtained on the proximate cause or source of this curious illumination. Mr. Macartney, in the Transactions of the Royal Society, has given an interesting detail of experiments and observations on several luminous insects. In the *lam-pyris noctiluca*, and in the *elater noctilucus* and *ignitus*, the light, he observes, proceeds from a substance not distinguishable from the interstitial substance except in its colour, which is yellow. The light-yielding matter reposes under the transparent parts of the skin, through which casement it is seen; and he infers that the luminous matter in the glow-worm is absorbed, being replaced by the interstitial matter when the season for emitting light is gone by. He observed two minute elliptical sacs formed of an elastic fibre, wound spirally, and similar to that of the tracheæ, which contained a yellow substance, soft in consistency, and closer in texture than that lining the adjoining region, and affording a more brilliant and permanent light. This light he concluded to be less under the control of the insect than the luminous substance in its vicinity, which he infers it has the pro-

perty voluntarily to extinguish, referable to some inscrutable power dependent on volition, and not, as was advocated by Carradori, by retracting it under a membrane : when he extracted the latter from living glow-worms, it afforded no light, while the two sacs in like circumstances shone uninterruptedly for several hours. The reason, however, of the apparent extinction of the luminous matter in the penultimate and antepenultimate annulæ, we have found to be the envelopment of the luminous matter by the surrounding interstitial mass, and if it be carefully sought for, it will be found deeply imbedded in it : this is the reason of the eclipse. Mr. Rogerson says the eggs of the insect are luminous, and we have certainly found luminous matter excreted from the glow-worm. This occasionally displayed, and oftentimes merged and lost in the common interstitial mass, may be the *ova* ; at any rate, when the luminous matter is found, it appears under the form of a congeries of minute brilliant points. Mr. Macartney is of opinion that the interstitial substance which surrounds the oval yellow masses under the transparent spots in the thorax of the *elater noctilucus* has the power of exhibiting light ; in which inference he considers himself warranted from the radiated structure of this substance conjoined with the translucency of the adjoining crust. This observer was unable to conclude upon the peculiar organisation that contributed to the efflux of light in the hollow projections of *fulgora lanternaria* and *candelaria*,—the hollow antennæ of *pausus sphærocerus*, and that under the entire integument of the *scolopendra electrica*. Respecting the *scolopendra electrica*, he conceives that it will not shine unless it be previously exposed to solar light—this conclusion is, however, not warranted by the premises. He has even in other cases inferred

that solar light is injurious to luminous animals, and that in the case of one at least of those in the sea — it retreats from the surface. He tried electrical stimuli, but supposed them to act merely as mechanical powers in educing light.

Dr. Darwin supposed that the luminous exhibition was owing to a secretion of some phosphoric matter, and a slow combustion arising from this phosphorus entering into combination with the oxygen inspired — the large spiracula in glow-worms seemed to give a plausible colouring to the idea. It was also stated that the light was increased by heat and oxygen — and extinguished by cold, also hydrogen, and carbonic acid gas. We have clearly ascertained, however, experimentally, that the luminous matter does *not* contain phosphorus — that the light is not sensibly increased by the purest oxygen — and is *not* extinguished in hydrogen and carbonic acid gas. Spallanzani regarded the luminous matter as a compound of hydrogen and phosphoretted hydrogen. Carradori found that the luminous matter of the *lampyris italica* shone in vacuo, oil, water, and under other circumstances, to the exclusion of oxygen; and he and Brugnatelli concluded, that the emission of light was owing to its absorption in food or air, and subsequently secreted in a sensible form. Mr. Macartney ascertained that the light of the glow-worm is not diminished by immersion in water, or increased by the application of heat. We find, on the contrary, that the maximum of brilliancy is exhibited at 98° or 99° Fahrenheit, while it declines as this temperature is increased. Foster and Spallanzani assert that glow-worms shine more brilliantly in oxygen; while Beckerheim, Dr. Hulme, and Sir H. Davy, discovered no such effect — and to these last we adjoin our testimony. Spallanzani and Dr. Hulme state that

the light of the glow-worm is extinguished in hydrogen and carbonic acid gas. Sir H. Davy, on the other hand, found that the light was not sensibly diminished in hydrogen, and we have not only found the same thing, but that the animal itself does not seem to suffer materially in this gas; and though it expires in carbonic acid gas, the light suffers no eclipse by the fate of the insect. Dr. John Davy found, at Kandy, on the 30th of June, while the air was 73° , that the temperature of a large species of glow-worm was 74° Fahrenheit; and we have seen the thermometer affected by nearly a degree from suffering the glow-worm to crawl over its bulb.*

On the night of the 10th of June, 1822, on returning from Llanymennech to Oswestry, in Shropshire, we picked up two glow-worms from the grass on the roadside. The brilliancy was intensely beautiful — the penultimate and antepenultimate rings of the under side of the abdomen were the portions illuminated, together with two luminous points on the anal segment; The night was dry, and much lightning prevailed: we repeatedly held the insects exposed and attached to the spikes of grass to the repeated flashes of lightning which played on them, but this seemed by no means to disconcert them; for their luminous paraphernalia remained still unveiled. One placed on the watch-glass gave sufficient light to ascertain the hour: we arrived at half-past 10 P. M., and introducing them into a room with a candle, the light gradually diminished in intensity, and became ultimately extinct, attenuating from the edges of the bands or discs, and disappearing in patches toward the centre. The thermometer stood at

* Dr. Todd transmitted to the Royal Society a paper on the glow-worm, subsequent to our communication on the subject to Linnean Society. It appears to contain no novelty.

70° F. The insects, when undisturbed, seemed anxious to gain the summits of the blades of grass toward evening and at night, and from thence displayed their beauteous insignia by holding up the lower rings of the abdomen. When they had ceased to shine, as well as during the day, they sought the roots of the grass. The luminous matter was carefully inspected by a lens, but not the slightest undulatory motion could be perceived which might connect it with any thing like combustion, and the luminous matter appeared incased in a transparent sac. On the 12th of June, at 20 minutes past 7 P. M., excluded from light, it had already kindled up a faint beam: when the insect was exposed to light, it ceased to shine, and appeared annularly translucent in the membrane which covered the luminous belts. At 50 minutes past 9 P. M. it shone exceedingly bright; still, by the most careful inspection, no undulatory movement could be seen, which proves it not to be a languid combustion, and though the light evidently intermits, it does not glow as in aphlogistic exhibitions. While it remained attached to a spike of grass, we could easily read a letter by the light it shed, by moving the insect over the lines. About this period, thermometer constantly ranging from 70° to 80° F., the glow-worm shone most vividly, and one was so intense on the road from Oswestry to Ruyton, that a horse started at the gleam, and nearly overthrew its rider. Our observations would certainly prove that the luminous matter is under the control or management of the insect, and we have noticed that the light is kindled up when it moves on the leaf, and its *palpi are then employed*. We once found five luminous specks, of a minute oval form, in the box which contained our glow-worms: they were evidently secreted by the insect, and might be

the ova. They continued luminous for some time, the light was of a different tint of colour, which may be accounted for on the simple intervention of atmospheric air in one case, and the transparent film of the membrane which enveloped it, in the other. We always observed that our glow-worms concealed themselves during the day among the roots of the grass, and that they feed *only* at night seems very evident. On holding the candle near, they do not withdraw their shining immediately, but it gradually attenuates. We let one fall on a cold slab of marble, but it still shone brilliantly — the insect, doubtless, having the power of sustaining a superior temperature.

The physical strength of the glow-worm seems not inconsiderable: we had about two dozen in a box, supplied with grass and moss: the lid was loosely tacked down, and seemed secure enough for them: in this, however, it appears we were mistaken; for, on returning home one night, the lid of the box had been detached, and our glow-worms scattered on the carpet of the room, which appeared powdered with diamonds. We must acknowledge here our obligations to T. N. Parker, Esq. of Sweeney Hall, through whose kindness we were abundantly supplied with these insects for the purpose of experiment, his servant having, by his desire, collected them for us.

After the luminous sacs were detached from the glow-worm, the light in the penultimate and antepenultimate rings was absorbed, with the exception of the two luminous points on the anal sac. But by proper pressure, the luminous spherulæ might be detached entire, and if not crushed or lacerated, would continue to evolve light after their detachment from the nidus in which they were imbedded. The luminous globules are altogether independent of the inter-

stitial substance throughout which they are diffused. The fact of the gradual and not instantaneous evolution of the light, and the slow eclipse it suffers, seems to refer the phenomenon to the volition of the insect—the intervention of a shade or contraction of the fibres to which the luminous points are appended, would account for the occasional occultation of the light. The luminous matter heated in a platinum spoon soon ceased to evolve light: the surface of the platinum exhibited no change, which it would have done had the luminous matter contained phosphorus as one of its chemical constituents. The light of the glow-worm seems monochromatic, and appears incapable of further decomposition by the prism. Viewed through a prism of rock crystal turned on its axis, it presented a confused nebulous image, unaccompanied with any chromatic tint. The photometer was affected by 2° or 3° on its near approach: this could only be inferred from the apparent sinking of the liquid, calculating from the moment of observation to that when it became stationary. The luminous spherulæ secreted from the insect, when dry, were heated over a spirit lamp in a platinum spoon: they became dark brown, and exhibited a momentary flame, accompanied by slight explosion, the flame, in colour, &c. had all the characters of hydrocarbonate; and, by a delicate chemical analysis, we have inferred it to be a gummo-albuminous substance. Luminous spherulæ detached from the glow-worm were immersed in various media to ascertain the period of continued luminosity. In a concentrated solution of pure caustic potassa, the light was of a bluish tint, and seemed to undulate: the period of duration was 60 seconds, and it continued luminous for several minutes in tincture of iodine. In sulphuric acid, of specific gravity 1.85, it was luminous

for 30 seconds, and finally became black. In muriatic acid, specific gravity 1.12, the light remained for 24 seconds; but in nitric acid, specific gravity 1.45, it was only luminous 10 seconds. In a subsequent experiment with sulphuric acid, specific gravity 1.85, it remained luminous only 20 seconds. In alcohol, specific gravity .812, the luminous appearance lasted nearly two minutes; and in camphorated spirit of wine, the same period; in caustic ammonia it was luminous for 60 seconds; in almond oil, and in water at 68° Fahrenheit, it continued luminous for some hours, but was much less brilliant and beautiful than when immersed in oil of olives. When put into olive oil, at 11 o'clock, P.M., it continued to yield light through the entire night, and several successive ones: when reposing in this tranquil medium, and viewed at a distance of about 10 feet, it twinkled like a fixed star; and although the eye steadily and tranquilly observed the beautiful phenomenon, the light seemed subject to occasional occultation, as if some axial revolution had been super-induced; and this curious eclipse took place in periodic times — but we could not determine whether this phenomenon was dependent on some property inherent in the light, or the result of circumstances connected with the organ of vision, or the air. Two glow-worms were shut up in a dark box from Tuesday morning to Saturday night; yet, when then examined, were shining with great brilliancy — a fact which tends to prove that previous exposure to light is not necessary to their luminosity, and conjoined with the circumstance that during day they penetrate to the roots of the grass, or moss, would lead us to conclude, that solar light, on the contrary, is injurious. When we breathed on a glow-worm not previously shining, it became luminous

— probably from the accompanying increment of temperature. The luminous matter continued to shine, without alteration, in oxygen, nitrous oxide, hydrogen, carbonic acid gas, cyanogen, olifiant gas, and nitrous gas. When the insect was introduced into pure oxygen, obtained from chlorate of potassa, it did not seem more alert than before; neither, in repeated trials, was the luminosity perceptibly increased. A glow-worm was not injured by being introduced into a medium of hydrogen, nor did the light undergo any change; in carbonic acid it soon exhibited signs of suffering, and expired in a bright shroud of light it had no power to quench; and this light continued a considerable time after death.

Light does not seem to exercise any control over the luminous matter when reposing in oil of olives; indeed, a luminous spherule exposed for an entire day to the sun-beam shone at night as usual, or with slight decrease of intensity. A luminous spherule held in the warm hand, say 98° F., for two minutes, continued luminous as in ordinary circumstances; it was then introduced into oil of olives, where it shone uninterruptedly. In water heated to 108° F., the luminous matter continued to shine for more than a minute; in a temperature of 114° F., it became extinct in about 40 seconds; in 126° , it was lost in 30 seconds; in a temperature of 94° , it became *faint* in 60 seconds, though it continued to emit light much longer; in a temperature of 99° F., the light was more *brilliant* and *beautiful* than in any other to which the luminous matter was submitted, and it continued more intense for about 60 seconds than under any other circumstances. A glow-worm, not luminous, was introduced into water at $64^{\circ}.5$ F., but no light was emitted— at a temperature of 88° , light was faintly emitted at the

last, or anal segment. In water of the temperature of 110° F., it crawled about apparently disconcerted, emitting two gleams, which were as suddenly quenched; but on being withdrawn, did not seem inconvenienced. The insect died at a temperature of 125° F.; but being suffered to remain in water at 116° F., light was educed, became extinct in 90 seconds, and could not be rekindled by a temperature of 156° . The maximum of brilliancy obtains at a temperature of 99° , and is less intense and less permanent at temperatures superior to this grade; while it may be inferred, that the temperature at which the animal dies is also that at which the luminous matter becomes particularly faint and evanescent.

When we plunged the luminous spherule in naphtha, it was apparently immediately extinguished; but this seemed to be in consequence of the opacity of the fluid, for when withdrawn it shone with undiminished brightness. In solution of nitrate of silver, it shone for some minutes with undecreasing light; in ethereal solution of gold, the luminous matter ceased to shine in 65 seconds — perhaps from a deposition of a film of gold on the luminous spherule; in concentrated chromic acid, it remained luminous for several minutes — the acid being opaque, the duration was determined by withdrawing the luminous matter from the liquid. When we pressed the luminous matter into a flat disc, the light appeared momentarily, as so many minute scattered points, which became promptly evanescent from the rupture of the capsule including it. Two spherulæ, with a portion of the interstitial matter, were detached from a glow-worm: on being withdrawn, they emitted light, but by a contractile power, soon became imbedded amid this substance, from which they could, however, be easily expressed, and

then shone as at first. This luminous matter appears, from our experiments, to be of a spherical form, included in a capsule perfectly diaphanous, or transparent, and which, when ruptured, unfolds the included luminous matter in a liquid form, of the consistency of cream. The luminous substance, there can be little doubt, remains *permanently luminous*, and the eclipse seems entirely occasioned by the spherulæ in which the luminous principle resides being withdrawn by a contractile movement into the darker recesses of the body of the insect, or being embosomed in the interstitial substance. In one instance, when the weather continued warm, the thermometer being above 70°, a glow-worm was accidentally crushed on the floor, yet the light continued visible for three or four days. We remember to have picked up a *lampyris noctiluca* on the road from Ouchy to Lausanne, which had been accidentally crushed,—it was still luminous.

We transferred a spherule into oil of olives in a small glass capsule, and viewed it under the lens of the microscope: it was opaque, of a bean shape, and indented; slightly chromatic at the ends when illuminated by the reflector from below, being at one end fringed with blue, and at the other reddish yellow—the matter being itself yellow, and environed by minute air bells. The luminous matter, divided by a lancet, previously gilt with etherised gold, in order to ascertain whether the hemispheres, thus separated, would exhibit a luminous annulus surrounding the central mass, did not discover such an effect, the luminous matter was instantly dissipated, and hence seems subtle and volatile; for a portion of the same being instantly transferred to muriate of platinum, remained luminous for 85 seconds, while the rest had ceased to be

so in less than one fourth of that period. This last experiment proves, that though the luminous matter may, when undisturbed in its capsule, remain even for hours luminous, it is volatile and subtile when its containing membrane is lacerated or destroyed. The corrosive medium, even of a solution of nitromuriate of platinum, could act only on the exterior wall, and not affect the luminous matter imprisoned within its confines. The yellow spherule, viewed by candle-light in oil of olives, seems to be surrounded by a cloudy atmosphere. When, from extreme cold, it had ceased to be luminous in the dark, we held it immersed in olive oil in a thin glass capsule in the warm hand for five minutes, it then emitted a faint nebulous light. This resembles the character of some of those substances called solar phosphori; for instance, the *chlorophane*, of which we possess a specimen that, held in the hand, evolves a fine green light.

We are wont to contemplate light as associated with the production of combustion, or the offspring of chemical action; but here is a light under a peculiar form, and independent of chemical conditions. The following appear to us corollaries deducible from the preceding detail of experiments:—

I. Light, as connected with the glow-worm, is a subtile evanescent material principle, perhaps connected with a peculiar organised structure, circumfused round the vitellula of the ovum, or integrating with it; unsupported by any chemical action, and confinable by the transparent film, or capsule, which imprisons it.

II. This light is permanent, and independent of any power possessed by the insect over it, except so far as it can withdraw the luminous matter from the window, or transparent medium through which it is

discerned, burying it in the interstitial matter, or secreting it under an opaque shell.

III. The light is not connected with any of the functions of animal life, as to its support or continuance, such as the spiracula or breathing apparatus, though it be so indirectly through the medium of the circulation, and to which its variable intensity seems attributable; and even the extinction of life itself does not extinguish the power and property of emitting light.

IV. The luminous matter is not adherent exteriorly, but included in a capsule, which preserves it from extrinsic agency and contingency.

V. The light seems associated with peculiar organisation, which elevated temperatures destroy, perhaps by decomposition, but which low temperatures only temporarily suspend. This very suspension, indeed, by cold, and restoration by warmth and by a temperature equal to that of animal heat, goes far to prove a peculiar function, *inherent in the capsule*, capable of educating and sustaining the phenomenon.

Mr. Spence, in a communication to Mr. Loudon *, states, that Dr. Carus of Dresden has made the discovery, that there is a connection between the circulation of the blood in the *lampyris italica* and the luminous matter which occupies a great part of the under side of the abdomen, and that the varying intensity of the light is thus produced, the greater intensity corresponding precisely with each pulsation of that fluid, being from 44 to 54 times in a minute, when the insect is not disturbed, but more rapidly and irregularly when alarmed: we are informed that the gleams of light in the *fulgora lanternaria* also vary in intensity, and doubtless the cause is a similar one.

* Magazine of Natural History, No. XI. p. 49.

The entire phenomena of the exhibition of light in luminous terrestrial animals seems to us to hinge on a *thermo-electric* principle. We have clearly proved experimentally, that the light varies in intensity with specific temperatures, and the variations of temperature connected with a languid or accelerated circulation will account satisfactorily for the change of intensity in the light. That in the ova, in all probability, depends on the vitality of its *punctum saliens*; and while we have observed, constantly, the intermission in its intensity in the living glow-worm, which has been ascertained by Dr. Carus to have a correspondence with the circulation, we never observed any such varying intensity in the ova protruded from the insect, or the luminous matter insulated from the body of the animal;—circumstances which seem to corroborate the view we have taken of it. Various have been the opinions hazarded on the part to which this singular phenomenon is subservient in the animal economy: in the common glow-worm it has been supposed to be a hymeneal torch, like the lamp that lighted Leander to Hero's bower. To this opinion many objections may be opposed. The male as well as the female glow-worms are luminous; the one is winged and the other apterous: the light is visible in autumn as well as in summer, when it cannot be required: the *scolopendra electrica*, which crawls on the earth, as well as the *elater*, *fulgora*, &c. which soar in the air, are luminous in both sexes. In fact, we are inclined to think it is a kind of *ignis fatuus*, by which its prey is more readily secured, just as the moth or the gnat, attracted by the flame of the taper, rushes on self-destruction. The employment at the moment, of its *palpi*, seems to corroborate the conclusion. This seems in our opinion to be its chief

purpose, and it would be difficult to conceive of one better suited. That pest of an Italian clime, the mosquito, is supposed to be the prey of the *lampyrus italica*, and thus may the *culex pipiens*, *tipula*, &c. become the food of winged and apterous luminous insects.

“ ’Tis only when the sun hath left his throne,
 And evening’s twilight darkens into night,
 When gentler stars and planets shine alone,
 That the small glow-worm sheds his topaz light,
 And feeds his lamp in solitude’s recess :
 Even so do truth and wisdom loveliest shine,
 Even so doth virtue most benignly bless,
 And love thus beams from some o’ershadowed shrine.”

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